Declaration

I hereby declare that this thesis has not been previously published or written by another person; neither has it been submitted nor accepted for any other academic award. It is the result of my original work carried out at Brandenburg University of Technology Cottbus, Germany, within the framework of the doctoral program in Environmental and Resource Management. All materials from other sources have been duly and adequately acknowledged.

Vincent Onyango

Cottbus, 1st September 2009

Confirming SEA Definitional Concept: Assessing the Extent to which SEA and Environmental Integration can be Evaluated Quantitatively and Behaves Systematically

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by

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Thank you all!

Abstract

Strategic Environmental Assessment (SEA) is a concept and a decision-making support tool. Based on its definitions, it is claimed that SEA can 1) contribute to the integration of environmental concerns into strategic decisions: policies, plans and programmes (PPPs); and that SEA 2) is a systematic process. Although these claims are widely acknowledged in SEA research and practice, they remain largely unsubstantiated empirically. To date, SEA research is dominated by qualitative-type approaches, investigating aspects of effectiveness, of context and of elements of good practice. Quantitative-type research has been rare, and often criticised on the basis that it is unable to capture and address the dynamic nature of PPP-making processes, i.e. the involvement of a wide range of actors, the input of new information and the existence of different views and interests, which give rise to uncertainty and unpredictability. Nevertheless, the potential of quantitative research in SEA has yet to be fully explored, and the extent to which SEA is meeting the two definitional claims mentioned above remains untested and undetermined. Within this context, this study aims to apply a quantitative research approach to SEA and verify the extent to which SEA contributes to environmental integration (EI) and the extent to which SEA behaves systematically. It achieves this by looking at UK practice as a case study. It applies questionnaire survey, correlation analysis and sensitivity analysis as methods of quantitative research approach.

The findings of this research confirmed that quantitative methodologies can be successfully applied to evaluate the presence and quality of SEA procedures and their outputs. Furthermore, the degree of EI reflected in plans and programmes (PPs) because of the SEA, as reflected in the PP's environmental objectives and indicators, can be quantitatively evaluated. However, to enhance this quantitative evaluation process, clearer and more precise environmental objectives are needed. Of the two definitional SEA claims evaluated, that (1) SEA contributes to EI in PPPs and that (2) SEA is a systematic process), there was weak evidence to support the claim that SEA significantly achieved EI within UK SEA practice. Of the second claim, it was concluded that the UK SEA process behaves as a systematic process composed of negative and positive feedbacks. Moreover, the UK SEA process is a stable system prone to over-development and with inadequate negative feedbacks to facilitate self-regulation of the SEA process towards a certain range of EI.

Based on the findings, it is recommended that if SEA effectiveness and theory-building are to be enhanced, application of more quantitative methods and hypothetico-deductive paradigms

of scientific enquiry should be applied in order to test and verify stated hypotheses. Application of other quantitative methods such as Factor Analysis and/or Principal Component Analysis should be considered in order to further establish the explanatory elements for EI achievement, and contributory roles of various SEA elements in achieving EI. Furthermore, quantitative approaches can facilitate calibrating of SEA reports and EI achieved, and enhance standardisation and quality control. It is further recommended that if SEA is to be understood as a systematic process with dynamic interactions amongst its elements, then further research needs to be conducted to improve follow-up mechanisms and establish quality hold points in order to enhance quality assurance. Specifically, more negative feedback loops or best practice standards and quality control hold points should be integrated into the SEA system in order for it to better self-regulate towards achieving a defined range of EI.

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Lists of Acronyms and Abbreviations

Admin.	Administration
Art.	Article
Cor(r)	Correlation
EA	Environmental Assessment
EC	European Commission
EEC	European Economic Commission
EI	Environmental Integration
EIA	Environmental Impact Assessment
Env.	Environment(al)
EPA	EPA Environmental Protection Agency, of the United States of America
EPI	Environmental Policy Integration
ERDF	European Regional Development Fund
EU	European Union
HMSO	Her Majesty's Stationery Office
IAIA	International Association for Impact Assessment
IEMA	Institute of Environmental Management and Assessment
JSA	Joint Staff Assessment
Mgt.	Management
NEPA	US National Environmental Protection Act of 1969
Obj(s).	Objectives
ODPM	Office of Deputy Prime Minister
OECD	Organization for Economic Cooperation and Development
OSPA	Opportunity Space Approach
Para	Paragraph
POST	Parliamentary Office of Science and Technology
PP(s)	Plans and Programme(s)

PPP(s)	Policies, Plans and Programme(s)
PRSP	Poverty Reduction Strategy Paper
RCEP	Royal Commission on Environmental Pollution
REC	Regional Environment Centre
SA	Sustainability Appraisal
SEA	Strategic Environmental Assessment
Sig	Significance
SMART	Specific, Measurable, Achievable, Realistic, Time-bound
SMRT	Specific, Measurable, Realistic, Time-bound
SMT	Specific, Measurable, Time-bound
SPSS	Statistical Package for the Social Sciences
UK	United Kingdom
UN	United Nations
UNCED	UN Conference on Environment and Development
UNDP	UN Development Programme
UNECE	UN Economic Commission for Europe
US	United States of America
USAID	US Agency for International Development
WCED	World Commission on Environment and Development

PART I.

RESEARCH CONTEXT AND FRAMEWORK

"Complexity is what interests scientists in the end, not simplicity. Reductionism is the way to understand it. The love of complexity without reductionism makes art; the love of complexity with reductionism makes science".

Edward O. Wilson (1998 p. 59).

CHAPTER 1 Introduction

Strategic Environmental Assessment (SEA) is an objectives-led, procedural, systematic and participative decision support instrument of strategic decisions e.g. spatial, transport and other sectoral policies, plans and programmes (PPPs) (Fischer 2007; Runhaar and Driessen 2007). Its aim is to ensure that environmental aspects are given appropriate consideration in decision-making for sustainable development, above the project level (Partidario et al. 2008). As a concept and a decision-making support tool, SEA is no longer a novelty (Gazzola 2006; Marsden and Dovers 2002) and has been accepted as tool of choice for achieving EI in PPPs (Gachechiladze et al. 2009; Palerm et al. 2007). Since the early 1990s, a wide array of definitions has been introduced (see Dalal-Clayton and Sadler 2005; Therivel 2004; Fischer 2002; Therivel and Partidario 1996; Wood and Djeddour 1992), but a universally accepted definition has yet to be agreed upon. Although different definitions emphasise different SEA aspects, e.g. impacts versus process or environment versus sustainability, they all have a common denominator. Almost all definitions claim that:

1. SEA aims to achieve and is likely to result into the integration of environmental concerns into strategic decisions, i.e. PPPs, and;
2. SEA is a systematic process[1] towards achievement of EI in PPPs.

SEA has been tasked with other objectives e.g. improving and optimising the overall PPP (Joao 2005) and increasing efficiency of environmental assessment as it reduces the number and complexity of project EIAs (Dalal-Clayton and Sadler 2005). Within this research, the scope of SEA tasks is limited to the above foremost two claims found in the SEA definitions. In this context, it is presumed that SEA is effective when these two claims are met. This does not exclude the fact that SEA effectiveness is also associated to public participation, institution- and capacity-building, as well as reflexive social learning (Chavez and Bernal 2008; Sanchez-Triana and Enriquez 2007). Furthermore, SEA effectiveness however defined, is relative to context (Fischer and Gazzola 2006). To date, the increasing practice and experience with SEA has encouraged researchers to explore its added value and establish whether it is supporting decision-makers in integrating the environment into PPP formulation

[1] An SEA process is the appraisal through which objectives of environmental protection and sustainable development are considered and factored into national and local decisions regarding Government (and other) plans and programmes (DECC 2009). It has also been defined as the environmental assessment that leads to an environmental report which should help inform policy choices (FoE 2005). The SEA process is broken down into steps of specific activities conventionally called procedures (Therivel 2004; EC 2003; Fischer 2002).

(Bina 2006; Fischer and Gazzola 2006; Bojo et al. 2004). Researchers have sought to demonstrate and ensure that through SEA's systematic and iterative application, SEA-aided PPPs are more environmentally sound and sustainable (Cashmore et al. 2004; Aschemann 2004; Fischer 2002; Bonde and Cherp 2000). When exploring effectiveness and validity of these two above-mentioned definitional claims, most researches have developed and followed qualitative-type research approaches (Runhaar and Driessen 2007; Sadler 2005; Cashmore et al. 2004). By contrast, SEA research using quantitative methods has been rare (see e.g. Eales et al. 2005; Fischer 2002) and at times criticized (e.g. Therivel 2002). Therivel argued that quantitative analyses do not allow for an "… understanding of what PPPs and SEA 'feel like'" (2002 p. 224). She then goes on to say that tables, statistical tests and analyses are based on peoples' opinions, thus information that is difficult to quantify and measure, within strategic contexts. Nevertheless, the potential of quantitative methods in establishing the extent to which SEA is effective has not been fully explored and its contribution to SEA research is not fully tested.

Almost two decades after its inception, there remains a lack of agreement about SEA benefits (see Noble 2006; Brown and Therivel 2000), as well as a lack of understanding of the extent to which SEA is meeting its objective of systematically achieving EI (Retief 2007; Runhaar and Driessen 2007; Dalal-Clayton and Sadler 2005; Fischer 2002; Sadler 1999; Eggenberger 1998). A lack of common understanding of the roles SEA can and should play in decision-making exists, and scepticism remains as to the benefits of SEA mainly due to the limited availability of tested methodological frameworks and demonstrative cases (Noble 2009). Moreover, it has been stated that theory-building in SEA is poor (Fischer 2002; Bartlett and Kurian 1999; Lawrence 1997), making systematic evaluation difficult. Theory-building within SEA, while not yet defined and fully elaborated on, is herein taken to mean the application of conventional scientific and empirical hypothetico-deductive processes to generate and verify grounded bases for accepting hypotheses and claims within SEA. Theory-building in SEA has been normatively described by some authors (see Cherp et al. 2007; Wiklund 2005; Bina 2003; Perdicoúlis et al. 2006; Cashmore et al. 2004). They explained the challenges in designing evaluative research in SEA and subsequently stated the need for more objective and rigorous SEA research in testing and verifying claims within SEA. However, literature on perspectives and challenges on theory-building in SEA have been few (see Nilsson 2009; Cashmore et al. 2008; Cashmore et al. 2007; Wallington et al. 2007; Fischer 2007).

Conventional hypothetico-deductive theory-building processes (see Figure 1.1) include theory generation and theory verification stages as well as other iterative steps of deduction and induction (see Carlile and Christensen 2005; Joppe 2000; Strauss and Corbin 1990; Kuhn 1962). These processes lead to empirically supported grounds that result in the establishment of theoretical concepts which are used in qualitative analysis to structure empirical predictions and observations within SEA.

The term "theory" therefore is a body of empirical understanding that researchers build cumulatively as they work through the steps in theory-building, increasing and continuously improving the corpus of knowledge as SEA evolves and develops. While qualitative type research approaches in SEA have largely generated descriptive theory at the bottom of the pyramid in Figure 1.1, the subsequent testing and improvement of these theories has been largely weak. The verification portion is represented within the top part of the pyramid depicting the theory-building cycle.

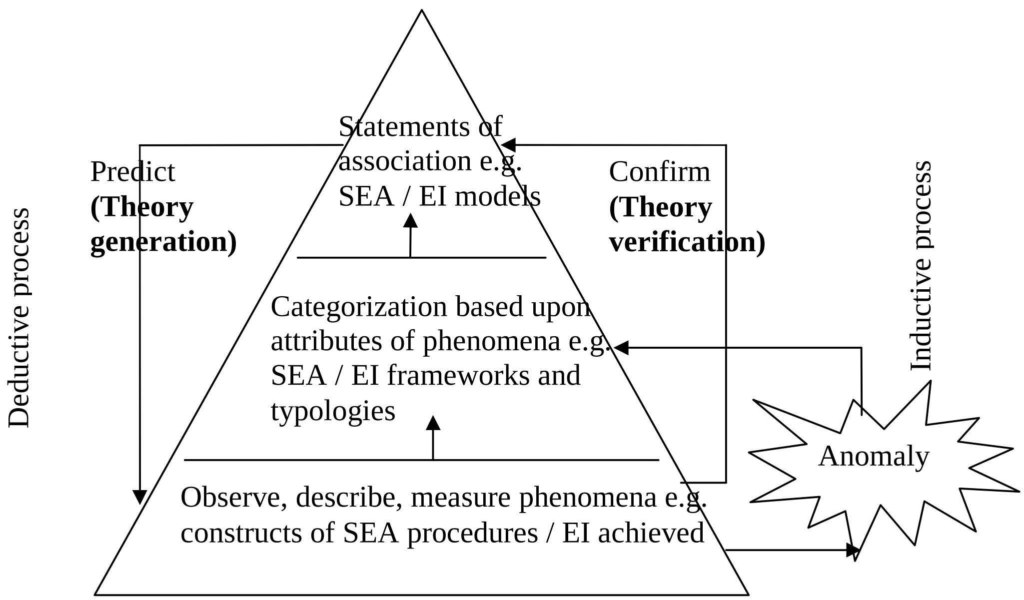

Figure 1.1: Process of theory-building according to hypothetico-deductive paradigm of science (modified from Carlile and Christensen 2005)

It is argued in this dissertation, that failure for SEA theory-building to adequately encompass all the theory-building processes has been because of inadequate application of quantitative research, in order to verify the claims and hypotheses from qualitative research approaches. Therefore, this domination of qualitative-type methods in SEA research has failed to fully define the added value of SEA to PPP-making and to verify the SEA definitional claims that are commonly acknowledged in the literature. The failure to empirically confirm the SEA definitional claims has been mentioned by several authors (Partidario 2007; Joao 2005; Therivel and Partidario 1996 Sadler and Verheem 1996; CEC 2001; Brown and Therivel 2000). It is stated that the earlier SEA definitions provided by Wood and Djddour (1992) and Therivel (1992) have been repeated without any supporting empirical evidence (Dalalal-Clayton and Sadler 2005). This over-reliance on qualitative methods has motivated this research. Within this context, it is suggested that the explanatory science remains wanting (Noble 2009) and that more empirical evidence is needed to establish the factors that contribute to SEA's systematic delivery of EI (Runhaar and Driessen 2007). Vicente and Partidario (2006 p. 697) summarised the state of art in SEA theory by stating "What SEA really is, what it delivers and how it should perform are still far from a consolidated stage". Therefore, this research applies a quantitative research approach to verify the validity of the two key SEA definitional claims, i.e. (1) whether SEA results in EI, and (2) whether SEA is a systematic process. The research is set within the context of the EC SEA Directive (hereinafter SEA Directive) and focuses on UK practice as case study. The remainder of this chapter presents the rationale and conceptual context within which the dissertation is set. Subsequently, the research aims and objectives are presented, followed by the structure and outline of the dissertation.

1.1 Research problem, assumption and hypothesis

The predominance of qualitative researches in SEA is identified as a significant problem that has hindered the verification of claims made in SEA definitions (Eales et al. 2005). Therefore, the research problem is the lack of adequate application of hypothetico-deductive models in SEA research. This is because the empirical evidence to verify the claims made in SEA definitions remains fragmented, inadequate and inconclusive (Runhaar and Driessen 2007; Vicente and Partidario 2006; Fischer 2002). Consequently, theory verification and theory-building through empirical hypotheses testing, is frustrated. Cashmore (2004) and Doyle and Sadler (1996) already suggested that robust empirical methods ought to be applied in order for causative phenomena in SEA to be understood. To date, confidence in SEA theories and capacity to fulfil its claims remains ambivalent among SEA experts and strategic decisions-makers (Noble 2006; EEA 2005; EEB 2005; Brown and Therivel 2000). The statement that SEA has been constrained by "doubts about robustness of results" and there is need to "clarify role of SEA" (Dalal-Clayton and Sadler 2005 p.27) aptly describes the problem. To undertake this research two testable hypotheses have been formulated as follows:

1) A higher score for presence and quality of SEA procedures[2] results in greater score for Environmental Integration (EI) achieved in PPPs;
2) Certain cluster(s) of SEA elements register a higher association with higher EI scores than others.

The first hypothesis is premised on the notion that PPPs subjected to complete and thorough SEA procedures score higher on EI, following findings by Bojö et al (2004) and Fischer (2002). In their study, they drew empirical inferences associating EI and SEA-type procedures in Poverty Reduction Strategy Papers[3] (PRSPs) and Transport and Land Use sectors, respectively. The second hypothesis derives from the observation that SEA literature claims that a cluster of certain SEA elements e.g. Scoping, Public Participation and Monitoring and Evaluation are key to determining quality of SEA outcomes or effectiveness of SEA (Hanusch and Glasson 2008; Sinclair et al. 2008). Moreover, it has been reported that elements for SEA effectiveness were not the same in all contexts (Fischer and Gazzola 2006); some of the elements for effectiveness in southern Europe were different from those in the northern. Therefore, if certain SEA procedures and contexts are more associated to determining EI, this dissertation assumes that quantitative research methods can establish this association. The first assumption is tested through correlation analysis (see section 2.4), and the second, both through the correlation analysis and the cybernetic[4] evaluation of the SEA process (see section 2.5), as depicted by the results of a sensitivity analysis.

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[2] SEA procedures are the fixed and widely accepted step-by-step sequence of activities, with definite start and end points, which must be followed within an SEA process. They include a formally recognised set of tasks stated in the EC SEA Directive, commonly screening, scoping, impact assessment and evaluation, options evaluation, mitigation, report preparation, decision-making and its review, monitoring and evaluation (SEA follow up), consultations and public participation (see also EC 2003; Fischer 2002; Therivel and Brown 1999).

[3] PRSPs are developing country poverty reduction strategies prepared through a participatory process. They describe the country's macroeconomic, structural and social policies and programs over a three year or longer period to promote broad-based growth and reduce poverty (Bojö et al. 2004)

[4] Cybernetics is a field of study that deals with "circular causal" relationships, in which changes in a system cause the system to change its behaviour and adapt to new conditions via information feedback loops (Vester 2007). Cybernetics provides a means for examining the design and function of any system, for the purpose of making it more efficient and effective (Black 1999; Von Bertalanffy 1968).

1.2 Justification for research

It has been argued that SEA lacks sound conceptual foundations, and that practice has developed well ahead of theory-building (Dalal-Clayton and Sadler 2005; Therivel 2004). Others indicated that the lack of solid SEA theories and of scientific rigour in elucidating and analysing values and judgements stems from the weak theoretical foundations of EIA, out of which SEA emerged (Lawrence 2003; Curtis and Epp 1999; Bartlett and Kurian 1999; Boothroyd 1995; Beanlands and Duinker 1984). Another group of scholars sees the limited use of *post hoc* assessments as one of the reasons underlying the lack of empirically grounded SEA theory (Arts 1998; Nelson and Serafin 1995). Developing theories in SEA has been complicated by the multi-faceted application of professional contexts, disciplinary roots and theoretical assumptions borrowed from other fields of studies (Noble 2009). The fields include management, natural and environmental sciences, social and political sciences and engineering, covering (Lawrence 2003):

- Planning theories largely represented by rational planning models;
- Traditional scientific theories presented by impact prediction models;
- Evaluation theories and procedures to screen and compare alternatives;
- Public policy and organizational theories; and
- Discipline-specific social, economic and biological theories to characterise environmental and sustainability conditions.

Several authors have questioned the validity of the science applied in SEA (see Cherp et al. 2007; Bina 2006; Perdicoúlis et al. 2006; Cashmore et al. 2004; Storey and Noble 2004; Lawrence 1997). Specifically, the over-reliance on qualitative type research in SEA has been criticised for presenting a major hindrance to SEA theory development (Cashmore et al. 2004) and effective practice (Curtis and Epp 1999). Expert judgement, commonly applied in SEA, has been described as being unscientific, prone to bias (Therivel and Wood 2005) and often unsatisfactory (Noble 2003). Despite the admitted conceptual and methodological challenges in evaluative SEA research (Retief 2007; Lee and George 2000; Bonde and Cherp 2000), convincing reasons for not applying quantitative research approaches in testing the validity of the claims in SEA definitions are lacking. Nevertheless, it has been cautioned that the complex nature of SEA does not easily lend itself to quantitative methodologies (Wood 2003; Therivel 2002; Elling 2000): and that assessing SEA effectiveness has proved to be extremely difficult at the strategic level (Chaker et al. 2006). Firstly, because it is difficult to disentangle the impact assessment stage from the policy process; and secondly, the long time scales involved in the life cycle of a PPP means that the effects of the SEA will take time to be realised (Therivel 2004).

Nevertheless, calls for undertaking empirically more robust systematic studies to determine SEA effectiveness and cause-effect pathways have been made (Retief 2007; Chaker et al. 2006; Fuggle 2005; Dalal-Clayton and Sadler 2005; Hilding-Rydevik 2003; Fischer 2002). The aim is to address the limitations of inadequate and inconclusive empirical evidence in order to verify the claims made in SEA definitions (Runhaar and Driessen 2007; Vicente and Partidario 2006; Fischer 2002). Consequently, it is posited that if the cause and effect pathways within SEA are better established, then application can be better configured to effectively deliver its objectives as claimed (Cashmore 2004; Doyle and Sadler 1996).

Whilst causation is a difficult concept with no easy definition (Brewer and Hunter 1989; Lincoln and Guba 1985), it has been inadequately addressed within SEA research (Perdicoúlis et al. 2007). It cannot be proven, but only inferred (Punch 2005). Although Miles and Huberman (1994) stated that it could be analysed by qualitative research, this has not proved satisfactory judging from the inconclusive evidence of SEA systematic achievement of EI (see section 1.1). The verification of this cause-effect is significant in the light of existing divergent views on SEA efficacy in delivering EI. On the one hand, it is argued that SEA contributes little to decision-making (Devlin and Yap 2008) and the whole system has structural and operational weaknesses with flexibility being used as a license for superficial consideration of environmental concerns (Fischer and Gazzola 2006; Jones et al. 2005). On the other, it has been observed that SEA is successful in achieving EI in land use planning (Kornov 2008; Elling 2005) and in other sectors (Caldwell 2004).

As an applied science[5], it has been stated that SEA research needs to meet the normative requirements of scientific rigour (Krawetz et al.1987; Beanlands and Duinker 1984). This implies that a strict demarcation has to be maintained between fact (the pursuit of science) and value judgements (the realm of decision-making) in theory and practice (RCEP 1998; Beanlands and Duinker 1984). The over-reliance on qualitative researches has led to the

[5] Applied science is the application of knowledge from one or more natural scientific fields to solve practical problems. SEA is an applied science because it is at the core of environmental technologies and employs environmental sciences to conserve the natural environment and resources and to curb the negative impacts of human involvement (Cashmore 2004).

exclusion of other empirical research approaches, leading Cashmore (2004) to observe that the inferences in the SEA literature were often based on little empirical investigation, and relied mainly on expert opinion. Moreover, it has been noted that no reasons are given as to why such expert judgments should not be subjected to critical assessment (Lee and Kirkpatrick 2006; Dalal-Clayton and Sadler 2005; Cashmore 2004; Noble 2003).

In a relatively young field of practice such as SEA, the embryonic steps towards theory-building require systematic examination of initial assumptions, theories, principles, and concepts (Retief 2007). This is a process of continual reflection upon existing SEA practice, to normatively explain it more clearly and to ultimately arrive at a more justified and refined understanding of SEA. Therefore, empirical results are needed in order to reconsider and gauge the validity of initial theories and claims, and contribute to establishing which SEA theories require further building (Storey and Noble 2005). Moreover, bridging the gap between theory and practice is critical for the development of sound and valid empirical basis upon which theory(ies) can be founded, generated and verified (Wiklund 2005; Hammersley 1992; Wolcott 1992; Brewer and Hunter 1989). Some researchers e.g. Jiliberto (2007) and Cashmore (2004) have stated that SEA needs to develop its own set of theories, apart from those of EIA. Theory is defined as an explanation or hypothesis designed to account for a phenomenon (Breheny 1983). It provides explanatory or prescriptive power, distinct from speculation and unsubstantiated assertions, enhancing the understanding of phenomena (Fischer 2007; Faludi 1973; Popper 1959). Furthermore, theory sensitises users to important variables in a situation (Fischer 2007; Goffman 1974).

Box 1: Proposed elements of SEA theories (Fischer 2007)

Main elements of a theory of SEA include:

• The characteristics of SEA, based on which benefits are thought to result,

• The reasons for why SEA is thought to be effective, and

• The factors that make SEA effective.

"Based on these elements, a more systematic approach to SEA is possible, revolving around 1) the choice of suitable processes; 2) the consideration of appropriate issues; 3) the choice of appropriate methods and techniques" (Fischer 2007 p.123).

Without theoretical rigour, predictions, assumptions, findings and methods cannot be fully and fairly represented and critically evaluated (Culhane 1993; Malik and Bartlett 1993;

Beanlands and Duinker 1984). Key elements of SEA theory have been proposed (Box 1). Having shown the inadequate state of SEA theory-building; and having shown that qualitative approaches have inadequately verified claims in SEA definitions, it is therefore justified to apply a hypothetico-deductive approach to verify SEA definitional claims. In this research, the claims embedded in SEA's definition, stating that (1) SEA achieves EI, and that (2) it is a systematic process, shall be treated as generated theories, *fait accompli*. This is based on three grounds. Firstly, in most SEA literature the claims are generally accepted and granted as true (see e.g. Schmidt et al. 2005; Mercier and Ahmed 2004; Therivel and Partdiario 2004; World Bank 2002; Dusik 2001; Partidario and Clark 2000; Sadler and Verheem 1996). Secondly, following Fischer (2007), these definitional claims correspond to elements of an SEA theory (Box 1), as they link the resultant EI in SEA-aided PPPs with the causal instrumentality of the SEA process, as explanation for the achieved EI. Thirdly, based on deductive analysis, taking the definitional statement as a theory presents a convenient methodological approach for theory verification (Punch 2005; Popper 1959). This normative stance justifies the need for verification of any claim that is entailed within a theory, by formulating a hypothesis in a form that could conceivably be tested through observable data and subsequently evaluated by looking at the extent to which the claims are fulfilled (Punch 2005; Clegg 2005; Wolcott 1992).

1.3 Research aims, objectives and questions

This research aims to verify the claims embedded in commonly accepted SEA definitions and establish the extent to which they are valid, through quantitative research methods. More in detail, it aims to establish the extent to which SEA systematically achieves EI in PPPs. To achieve the research aim, four objectives are identified:

- To gather opinions of experts on the role of SEA in achieving EI and on the validity of using quantitative research approaches in evaluating the effectiveness of SEA in delivering EI;
- To establish the correlation between procedural and contextual SEA elements, and EI;
- To explore the systematic nature of SEA process;
- To identify areas for further research that can expedite the effectiveness of quantitative methodologies in improving SEA theory-building.

To achieve the research aim and objectives, guiding research questions were formulated. These are:

- To what extent is the SEA process and EI amenable to quantitative evaluation?
- To what extent are the claims embedded in commonly accepted SEA definitions valid?
- What correlations and dynamics exist between and among SEA procedural and contextual elements, and how do they contribute to the achievement of EI?

1.4 Research approach and methods

The research applies a quantitative research approach. Since SEA research has to date been predominated by qualitative research, there is need to test and confirm claims in SEA definitions. In this context, quantitative methods such as questionnaire survey, correlation analysis and sensitivity analysis were chosen. To achieve this, the hypothetico-deductive model necessary in theory-building is appropriate because it involves methods effective at testing and confirming claims found in SEA definitions. Within this research approach a methodological framework that follows deductive and inductive analyses was applied. Deductive and inductive approaches draw empirical inferences and can be used to infer causality (Perdicoúlis and Glasson 2006; Morris 2005). In the inductive method (Figure 1.2), data are collected after observations and a causal relationship is induced, i.e. a generalised conclusion is inferred from the particular instances and patterns generated from the data (Williamson 2005). The inductive approach is used to identify tentative patterns, similarities and differences, from the empirical evidence gathered, leading to new explanations and/or hypotheses. Within this approach, extrapolated generalisations about SEA in the international context are made based on results from the UK samples (Williamson 2005). Such generalizations attempt to generate explanatory theory by deriving laws that should hold true in most cases (Hinton 2004).

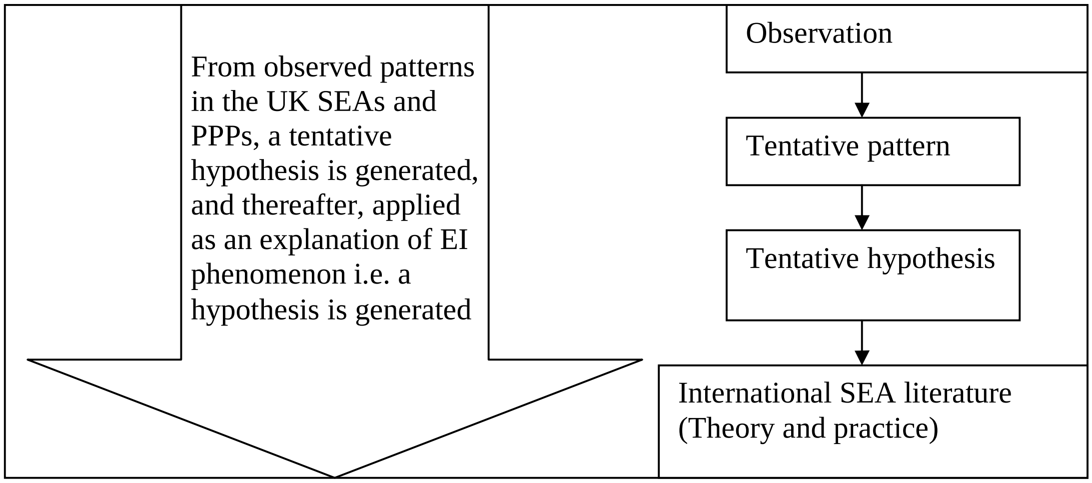


Figure 1.2: Inductive approach for theory-generation (adapted from Gazzola 2006)

In the deductive method, also known as variance theory, a hypothesis about a causal relation is formed, tested, and then accepted or rejected (Morris 2005; Williamson 2005). This type of causality analysis sets out to determine experimentally or semi-experimentally the presence of certain effects because of certain presumed causes (Figure 1.3).

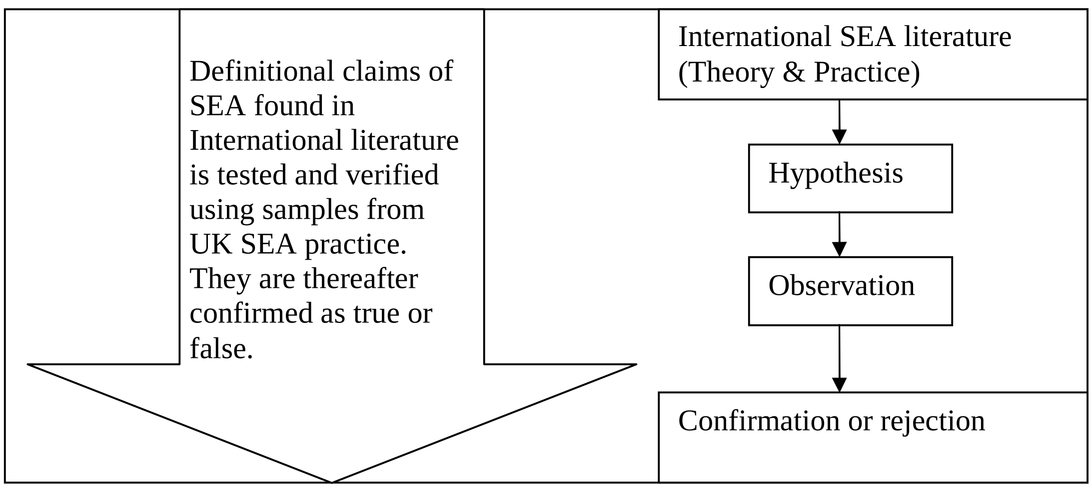


Figure 1.3: Deductive approach for theory-verification (adapted from Gazzola 2006)

The methods employed in the research are:

1) Questionnaire surveys to gather the opinions of UK SEA experts on the two claims upon which the research is based and investigate whether the need for more quantitative-based SEA research was supported. Results are expected to strengthen the empirical framework and enhance the validity of interpretation of results upon which

recommendations are made. Furthermore, by understanding the opinions of UK SEA experts, more grounded recommendations can be made.

2) Correlation analysis to establish association between the SEA procedures, their outputs and EI. This follows application of quantitative evaluation to generate numerical scores representing the presence and quality of SEA procedures and their outputs, and the quality of EI as represented by evaluation of statements of environmental objectives and indicators.
3) Sensitivity analysis to verify the systematic nature of SEA in achieving EI. This is done through a cybernetic evaluation of SEA as a system; and by simulating various scenarios in which different SEA elements and parameters are changed in relation to each other.

1.5 Expected contribution of research

The results of this research are expected to contribute to SEA practice and theory-building in three ways. First, SEA theory development (see Curran et al. 1998; DETR 1998; Kleinschmidt and Wagner 1998; Sadler and Verheem 1996; Therivel and Partidario 1996) will be enhanced by verifying the validity of SEA definitional claims and by revealing clearer insights into SEA's role in delivering EI. In this context, quantitative evaluations will reveal cause and effect between SEA elements and EI, more clearly. Second, from the domain of public choice, uptake of SEA will be promoted as political decisions towards SEA may be more assured if the uncertainty regarding its purposes and effectiveness are reduced (Buchanan and Tullock 1999). Finally, the debate over quantitative research approaches in SEA will be enhanced with more empirical insight concerning its applicability. This offers a sound empirical basis for suggesting recommendations for applying SEA and for improving practice, particularly in terms of achieving EI. Quantitative evaluations could also be employed in comparative analyses, for example when differentiating or ranking competing PPPs from an SEA or EI perspective. For example, more objective quality standards and thresholds can be formulated.

1.6 Structure of dissertation

The dissertation is organised into four parts. Part I, consisting of two chapters, presents the research context and framework and introduces the empirical input into the overall research. Chapter one introduces the research, its aims, objectives and research questions. In Chapter two, the research approach and methods are explained. Novel methods such as Opportunity

Space Approach (OSPA) used to quantitatively evaluate EI, and quantitative evaluation of SEA and EI, are explained in detail. The research analytical framework is also presented as well as the criteria followed in order to enhance validity of findings in the study.

Part II, consisting of two chapters, presents the background details from literature review upon which the methodology, results and recommendations can be grounded. Furthermore, it gives an overview of the state of the art in SEA evaluation and the rationale for applying quantitative approach to enhance theory-building. In Chapter three, background information to SEA is succinctly presented. This includes evolution, purposes and benefits of SEA. The two key SEA definitional claims studied in this research are also presented and explored more in detail. In Chapter four the relationship between quantitative evaluation, quantitative research and theory-building within SEA, is explained.

Part III consists of three chapters presenting the research results with an interpretation of the findings within the context of research objectives. Results refer to the outcomes or outputs of particular methodical operations e.g. results of correlation analysis in form of tables. A finding, on the other hand, refers to a conclusion reached after examination, consideration or investigation of the results, singly or in relation to other known informations. For example, a correlation analysis output may be a single number indicating probability, but after consideration of statistical significance levels, a new finding or conclusion may consequently be made. The results from questionnaire surveys are presented in Chapter five; results from correlation analysis and quantitative evaluation of SEA and EI, are presented in Chapter six; and results from sensitivity analysis are found in Chapter seven.

Part IV has two chapters and draws conclusions and recommendations based on the research findings. It aims to present the implications of research findings as well as new contribution to SEA within the scope of the research objectives. Chapter eight presents and discusses the research findings based on the research analytical framework. In Chapter nine, overall conclusions are drawn within the context of research aim and questions, and constraints experienced within the research, discussed. In this context, the lessons learnt and the scope for further research is presented. Figure 1.4 represents a simplified structure of the dissertation and depicts the relationships between the key research framework elements and research objectives.

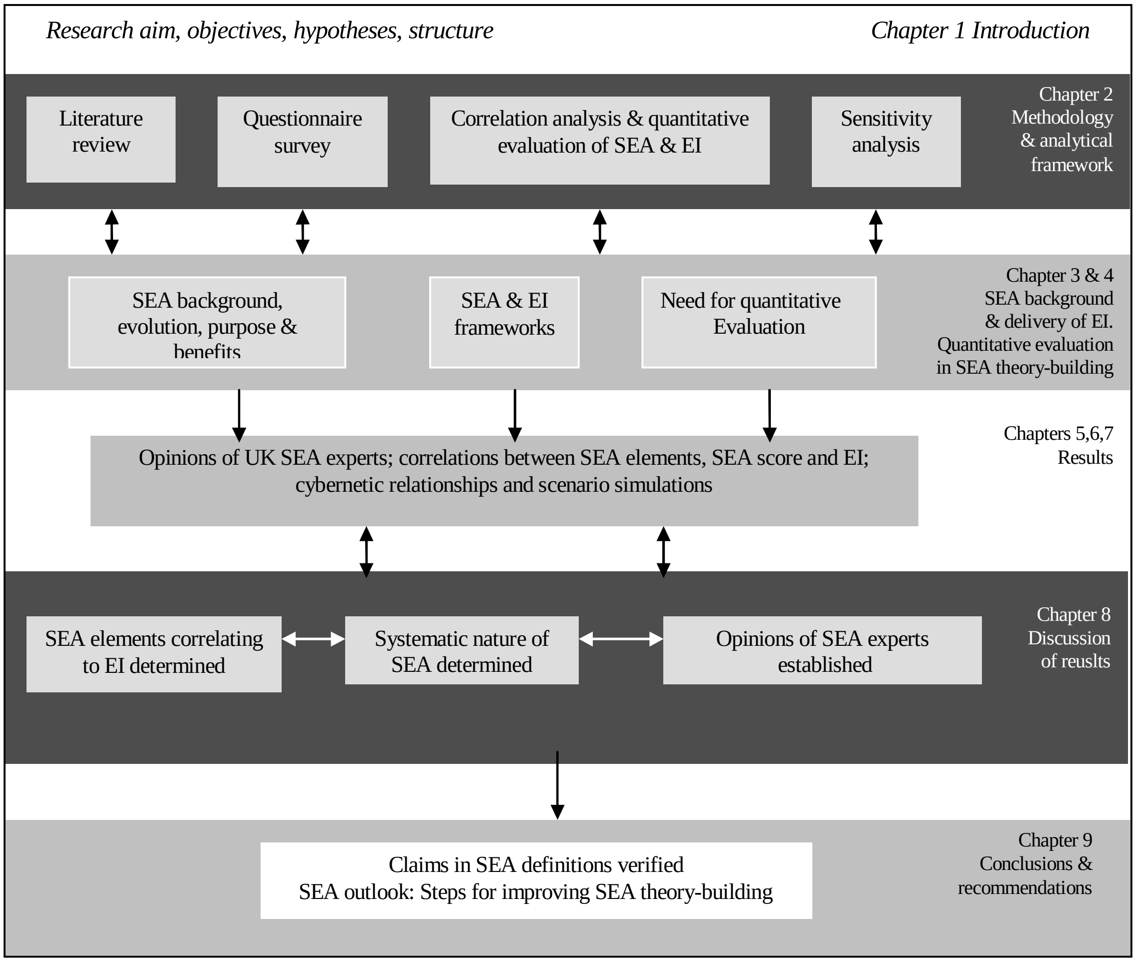


Figure 1.4: Schematic structure of study and relationships between research objectives

CHAPTER 2 Research Methodology

This chapter, divided into six sections, presents and explains the methodological and analytical frameworks applied in the research. The choice of UK as a case study is explained in section 2.1, followed by the research methods (i.e. literature review, questionnaire survey, correlation analysis and sensitivity analysis) from section 2.2 to 2.5. The scope and rationale of the literature review is presented in section 2.2 and the design and application of the questionnaire survey in section 2.3. The correlation analysis is presented in section 2.4, including a description of the quantitative approaches used to evaluate both the SEA procedures and their output, and EI in PPs. The description and application of the sensitivity analysis is presented in section 2.5 and the research analytical framework used to analyse and collectively interpret the results from the methods is presented in section 2.6.

2.1 Choosing the UK as a case study

As indicated in Chapter one and further explained in Chapter four, in spite of the predominance of qualitative research approaches, the empirical evidence to verify claims made in SEA are fragmented, inadequate and inconclusive (Runhaar and Driessen 2007; Vicente and Partidario 2006; Fischer 2002). Within this context, this research aims to verify the claims embedded in commonly accepted SEA definitions, and verify SEA systematic achievement of EI, through quantitative research methods. Looking at UK SEA practice as a case study does this. Three criteria were used for identifying the UK as a suitable case study. First, the UK has widely applied SEA over several years and therefore has a well-established and consolidated SEA tradition (Fischer 2005). Second, UK SEA practice has been widely explored in the international SEA literature, thus, there is a considerable body of research upon which this study can build on. Third, SEA reports and planning documents are easily accessible and widely available on the Internet. While other countries such as Canada have had long traditions with SEA-type procedures (Noble 2009), the choice of UK was decided not on empirical basis, but on familiarity of researcher with UK SEA practice. Furthermore, the bulk of contributions to international SEA literature was at 2006 dominated by UK and EU-based authors (Gazzola 2006). Within the UK context, PPs and their SEA reports were analysed. They were identified through an Internet screening process, which lasted several months. The SEAs considered were those conducted following the requirements of the SEA Directive. The list of PPs and of their SEA reports are provided in Annex 4 and the glossary of PP types is presented in Annex 5. As the SEA definitional claims are non-sector specific, SEAs from several sectors were considered in the study.

2.2 Literature review

Literature review aimed at exploring several contexts and definitions for SEA and EI and research approaches applied in SEA. Overall, it set the basis for research design, methodological and analytical frameworks. In detail, literature review focused on the use of quantitative research methods in the social sciences, and more particularly, in SEA. In this context, the strengths and weaknesses of both, quantitative and qualitative methods were highlighted, setting the basis for arguing the need for more quantitative approaches in SEA research. The reviews focused particularly on the international and UK SEA literature, and aimed to achieve the following objectives:

- To map and analyse the range of SEA definitions available and the two claims upon which the research is based (section 2.3).
- To identify SEA elements for the research analytical framework (section 2.4); the international SEA literature portraying various procedural and contextual elements to undertake evaluative research provided a basis to distil SEA elements for use in this research.
- To present an overview of the UK SEA and EI frameworks and identify the existing mechanisms for systematically achieving EI through SEA (sections 2.5 to 2.8).

2.3 Questionnaire surveys

192 questionnaires were electronically sent out to UK SEA practitioners to gather their opinions about the role of SEA in achieving EI and about their support for applying quantitative evaluation approaches to SEA and EI. The questionnaire design was structured according to three themes (see sample in Annex 6), which also represented the framework for analysing and interpreting the questionnaire findings. These are:

- What is understood by EI? (Section A and B of questionnaire)
- What is the role of SEA in achieving EI? (Section C of questionnaire)
- What is the contribution that quantitative evaluations can make in improving SEA's capacity to achieve EI? (Section D of questionnaire).

Questionnaire design

Structured and semi-structured questions addressing the themes of the questionnaire were formulated. The structured questions, in which the questions asked are decided in advance, aimed to reduce bias. The standardized questions, in which exactly the same questions are asked of all respondents, aimed to ensure reliability, generalisability, and validity of results. The semi open-ended questions were aimed at further exploring the attitudes and perceptions of respondents.

Choice of respondents

The questionnaires were sent out to UK SEA experts who were registered members of the International Association for Impact Assessment (IAIA). The membership database was consulted in June 2007. The IAIA was established in 1980 and has over 2,500 members in over 100 countries. Its vision is to be the leading global network on best practice in the use of impact assessment for informed decision-making regarding PPPs and projects. Its mission is to provide an international forum for advancing innovation and communication of best practice in all forms of impact assessment to further the development of local, regional and global capacity in impact assessment. The IAIA was chosen because it represents a leading authority within the field of impact assessment, including SEA, and is an umbrella body for international and UK experts (http://www.iaia.org). While the institute of IEMA is also a leading professional body with considerable membership by UK SEA experts (http://www.iema.net/iema), it was not selected in this research because the membership was considered predominantly of SEA practitioners. Therefore IAIA was deemed to have a more balanced representation of SEA practitioners, researchers and administrators.

2.4 Correlation analysis

To test and verify the hypotheses in this research correlation coefficients and findings of statistical significance were used. Correlation is the extent to which a variation in the score of one variable results in a corresponding variation in the scores of a second, usually in a linear relationship (Hinton 2004). While correlation coefficients cannot *per se* be used to infer a causal relationship between variables, it can indicate relation or association. This is despite the indirect and unknown causes underlying the correlation. Two-tailed tests were done, as prior assumptions on the association between SEA and EI variables were lacking (Clegg 2005). The data sets representing various SEA and EI variables were correlated using SPSS software version 12.0.1. A scatter diagram presented in Annex 7 indicated that most SEA and EI data sets generally had linear or curvilinear patterns, hence suitable for correlation analysis. The data were correlated using bivariate correlation function, and the Spearman's Rho Rank Correlation Coefficient was used to reveal the magnitude and direction of the correlation among variables (Punch 2005; Clegg 2005). The Kendall's tau_b Rank Correlation Coefficient was used as a measure of strength of correspondence between the variables. Since correlation coefficient can be interpreted as a measure of the closeness to linearity of a pair of variables, it can act as an estimate of the population correlation coefficient. Therefore, a hypothesis about the value of a population correlation coefficient in a population can be developed and tested.

Following the results of the tests, statistical decisions based on sample of evidence and on decision rules, are considered. If the null hypothesis is rejected, then the alternative is accepted as possible. The analysis is based on the hypothesis tests within the correlation analysis data that indicate the level of confidence that is derived in the association between SEA score, SEA elements, and EI scores. Judgement of weak, medium or strong correlation is done according to an indicative and normative classification in Table 2.1, and is not derived from any prior SEA-specific empirical studies. If the statistical evidence for association between any two variables is strong and significant, as depicted by correlation scores at 95% and 99% confidence levels, then conclusions on the association can be made with great confidence. Significance level is the risk (probability) of erroneously claiming a relationship between an independent and a dependent variable when there is not one (i.e. Type I error) (Hinton 2004). It sets the probability of making a Type I error of rejecting the null hypothesis when it is true. In statistical hypothesis testing, the null hypothesis is used to formally describe some aspect of the statistical behaviour of a set of data; this description is treated as valid unless the actual behaviour of the data contradicts this assumption. Thus, the null hypothesis is contrasted against another hypothesis.

Table 2.1: Indicative classification of strength of correlation (source: Hinton 2004)

Correlation	Negative	Positive
Weak	- 0.3 to - 0.1	0.1 to 0.3
Medium	- 0.5 to - 0.3	0.3 to 0.5
Strong	- 1.0 to - 0.5	0.5 to 1.0

Statistical hypothesis testing is used to make a decision about whether the data contradicts the null hypothesis in a process called significance testing, where a null hypothesis is not proven but either *rejected* or *not rejected.* Failing to reject it gives no strong reason to change decisions predicated on its truth, but allows for the possibility of obtaining further data and then re-examining the same hypothesis. This indication of association between SEA elements and EI, depending on corresponding confidence levels, will be used to infer whether EI corresponds to any changes in presence and quality of SEA procedures and their output. While the null hypothesis testing is widespread and plays a major role in testing the significance of differences in scientific and medical applications, it has been criticized on a number of grounds which are beyond the scope of this research (see Ioannidis 2005; Gigerenzer 2004; Cohen 1994). The null hypothesis stating there is no association between any two variables was tested against the alternate hypothesis at both 99% and 95% confidence limit levels. In this method the words 'SEA elements' and 'variables' were used interchangeably. The reading of coefficient scores was guided by the following criteria (Punch 2005).

- The coefficient has value 1 if the agreement between the two rankings is perfect (i.e., the two rankings are the same);
- The coefficient has value -1 if the disagreement between the two rankings is perfect (i.e., one ranking is the reverse of the other);
- For all other arrangements the value lies between -1 and 1, and increasing values imply increasing agreement between the rankings. If the rankings are completely independent, the coefficient has value 0 on average.

Table 2.2: Disaggregated SEA samples according to sectors

Category of SEA	**Number (% of sample)**	**Correlation done?**
Development	25 (46.25%)	yes
Transport	11 (20.35%)	yes
Waste	5 (9.25%)	no
Structural funds	4 (7.4%)	no
Offshore oil drills	3 (5.55%)	no
Minerals	3 (5.55%)	no
Floods	1 (1.85%)	no
Housing	1 (1.85%)	no
Wind	1 (1.85%)	no
Total	54	Yes – 2 categories No – 7 categories

In a second step, the data was disaggregated into PP categories according to the following sectors i.e. development plans, transport, waste and structural funds (ERDF) (see Table 2.2), and then tested for correlation and the results presented in Tables 6.5 and 6.6. A sample size less than 10 was considered unreliable for making generalised insights. In order to carry out the correlation analysis, input data was provided by the results of quantitative evaluation of both SEA procedures and their outputs, and EI, in SEA reports according to the quantitative evaluation frameworks subsequently explained in subsections 2.4.1 and 2.4.2.

2.4.1 Quantitative evaluation of SEA

Owing to its complex nature, the SEA process was disintegrated into key procedural and output elements, to allow for detailed examination. The SEA procedural elements basically correspond to those in the EC SEA Directive and are explained in section 4.4. The output elements are the outputs from the SEA procedures, as would be expected if the procedures were carried out according to SEA 'Good Practice'. SEA has been described as procedures-oriented, with the qualities of the procedures described as paramount to overall SEA quality, and consequently, effectiveness (Partidario 2005; ODPM et al. 2005; Thissen 2000). Under the SEA Directive, the SEA report is seen as the main output of an SEA process (Therivel 2004; CEC 2001); and the review of SEA reports has become common in SEA evaluation (see Tojo et al. 2004; Fischer 2002; Lee and George 2000; Bonde and Cherp 2000; Curran et al. 1998; Asplund and Hilding-Rydevik 1996; Sadler 1996). Whilst the quality of SEA reports has been suggested as important in reflecting SEA quality (Perdicoúlis 2005; Connelly and Richardson 2004), it has nevertheless been cautioned that even a legally compliant SEA process can be ineffective, resulting in poor quality outputs (Palframan 2006).

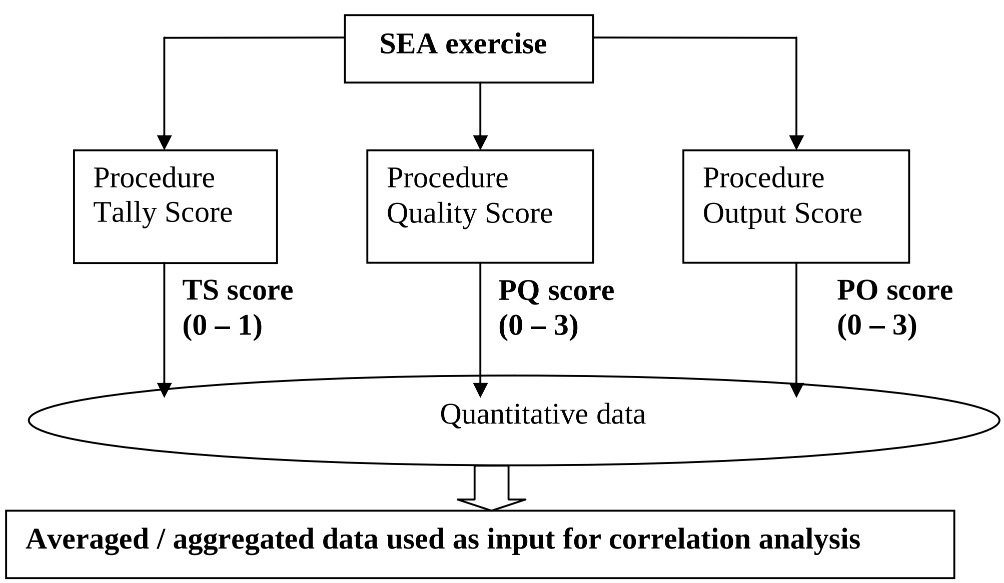


Figure 2.1: Schematic showing quantitative evaluation of an SEA report

Therefore, to cover all quality-related aspects, the presence and the quality of the SEA procedures and their outputs were evaluated. This evaluation approach is schematically summarised in Figure 2.1 and was guided by criteria presented in Box 2.

Data collection and processing

Since the SEA procedures and their expected results have been described in various literatures e.g. the SEA 'Good Practice', this was used as a reference against which evaluation was done. If the procedure or output was as expected from SEA 'Good Practice' a full score was assigned. Otherwise a score of 0 was assigned for no procedure or output, and any range in between was assigned using the provided reference scale (Box 2).

Box 2: Criteria guiding quantitative evaluation of SEA procedure presence (TS); procedure quality (PQ); and procedure output quality (PO)

Score	**Criteria**
3	Procedure clearly described and is evident in the SEA report (TS); Procedure carried out according to 'Good Practice' (PQ); Output of procedure is as expected from 'Good Practice' (PO)
2	Procedure present but not fully elaborated or evident in SEA report (TS); Procedure carried out satisfactorily but does not meet expectations of 'Good Practice' (PQ); Output of procedure is satisfactory but below quality expected from 'Good Practice' (PO)
1	Procedure alluded to and only slightly evident in the SEA report (TS); Procedure poorly elaborated, missing most relevant details (PQ); Output of procedure misses key items expected from 'Good Practice' (PO)
0	Procedure omitted (TS); Procedure not carried out (PQ); expected output missing (PO)

In summary, an SEA report was perused and evaluated according to the following steps:

- Presence of procedure was scored (Tally score - TS) between 0 and 1;
- Each procedure was compared if carried out according to SEA 'Good Practice' and given a score (Procedure quality score - PQ);

- The output of each procedure was compared with expected output had the procedure been done according to SEA 'Good Practice', and given a score (Procedure output score - PO);
- Scores from various procedures were aggregated or averaged, to provide a single score for each SEA report, as shown in Table 2.3.

Several combinations of the procedure tally score (TS), procedure output score (PO) and procedure output quality (PQ) were calculated, to give various representative scores for each SEA report at various levels of combination and aggregation (see Table 2.3). The various scores were thereafter used as input data for correlation analysis, and results are presented in Chapter 6.

Table 2.3: Notations of various combinations of SEA element and SEA scores

Score	**Notation**
Procedure score	PS = (PQ+ PO)/2
SEA score	SEAscore = (Σ PS)/8
SEA aggregate	SEAagg = (Σ (TS + PS))/8
Average tally score per SEA	Tsavg=(Σ TS)/8
Average procedure score	Pavg = (Σ PS)/8
TallyxPro score	Tallyxpro = (TS (avg) x PS(avg))

2.4.2 Quantitative evaluation of Environmental Integration (EI)

To quantitatively evaluate the extent of EI resulting from SEA, a method called Opportunity Space Approach (OSPA) was used. Following Kontio et al. (2005), OSPA offers two advantages. Firstly, it is a systematic framework for evaluating the extent and quality of EI in a PP document, as an output of decision-making. Secondly, it is based on the explicit statements of environmental objectives and indicators listed in PPs, ensuring therefore the transparency of the evaluation process. The application of OSPA is underpinned by the following assumptions that are subsequently explained:

- The act of integrating the environment is an output of a decision-making process;
- Explicit statements of environmental objectives and indicators are a direct proxy and reflection of achieved EI;

- The SEA process represents 100% opportunity space for EI in each PPP.

2.4.3 Background and conceptual basis of OSPA

Opportunity Space Approach (OSPA) was used by Kontio et al. (2005) to quantitatively evaluate the extent of EI in three EU Objective One Structural Fund Programmes[6], each having been subjected to an SEA process as is required by regulation (Bradley 2004). The OSPA results were presented at the SEA Conference of the International Association for Impact Assessment held in Prague, Czech Republic, 26-30 September 2005. In this application, it was demonstrated that EI could be assessed in strategic documents, based on the presence and quality of statements of environmental objectives and indicators. Furthermore, Kontio et al. provided an example of how a quantitative approach to EI evaluation through a method such as the OSPA could be relied upon to differentiate various extents to which PPPs had succeeded in integrating environmental concerns.

EI through SEA influence of decisions-making processes

SEA has been stated to influence the formulation of PPPs through “choice opportunities”, with several decision-windows, to impact on decision-making in favour of EI, as for example elaborated in the ANSEA project (Caratti et al. 2004). SEA is therefore used as a tool to influence these “choice opportunities” (World Bank 2002). OSPA relies on the understanding that the quest for decisional consistency must be environmentally oriented, for EI to be achieved (Gibson 2007; Caratti et al. 2004; Noble 2003). Within the context of this research, the SEA process is considered as an opportunity space, i.e. a “black box” with numerous spaces for decision-making moments and values (Jiliberto 2004; Therivel 2004). This consideration is important because the links between SEA and PPP-making processes are difficult to clearly identify (Therivel and Partidario 1996). The boundary of each “blackbox” is demarcated by the purpose of the PP, its decision-making culture and hierarchy and the SEA context and frameworks, i.e. defining the guidelines and regulations determining the way in which SEA and planning are practiced in different contexts.

According to the OSPA model, this space is called the *Theoretical Space*, encompassing the entire possible EI solutions that can be included into a PP (Kontio et al. 2005). However, in

[6] Structural Funds (ERDF) are funds allocated by the European Union for the purposes of supporting the poorer regions of Europe develop their infrastructure especially aimed at accelerating economic development. They prioritise the transport sector, human and physical capital, innovation, knowledge society, environment and administrative efficiency (www.defra.gov.uk/rural/structure/obj1.htm).

practice, this theoretical space is constricted by limitations, e.g. international agreements and national legislation, organisational structures and institutional capacities. This follows the bounded rationality of decision-making that accepts that decision-making takes place within the boundaries of limited resources, human capacity and values (Jiliberto 2004; Fischer 2003; Nilsson and Dalkman 2001; Simon 1957). Other types of limitations concerning the efficacy of the SEA tool and the effectiveness of its application further refine the theoretical space into what is known as the *Substantive Space* (Kontio et al. 2005). This follows the efficacy of application of the tool itself, in order to achieve EI. *Substantive Space* is therefore assumed to reflect the extent to which the instrumental capacity of the SEA tool has been utilized in achieving EI.

At each decision window, relevant environmental values are considered and integrated into the decision-making process, by the choice of environmental objectives, targets and indicators. The environmental values or criteria can be defined by an environmental protection agency or Responsible Authority that undertakes an SEA: and that nominates relevant objectives to ensure that the PPP is being designed within the context of achieving environmentally sound and sustainable development. For example, documents such as the EU's Environmental Action Plan or Sustainable Development Strategy provide a framework of relevant environmental objectives. However, in practice, not all decision windows for EI are fully utilised or incorporated into the planning process by the SEA. For example, if the 6th EU Environmental Action Plan has twenty environmental objectives and only fifteen of these are addressed by the SEA and incorporated into the plan, because of institutional or other limitations, there is a loss of opportunities consisting of five objectives. The loss of opportunities could further diminish at the subsequent decision windows and stages of PPP-formulation (Kontio et al. 2005). Another common reason suggested for such loss is that higher environmental PPPs are not specified and implemented at lower planning levels, i.e. lack of implementation, as stated in the repondents' questionnaires in Box 9.

Environmental objectives and indicators as proxies of EI

Generally, strategic actions (PPPs) are composed of objectives plus more detailed statements about how the objectives will be implemented (Therivel 2004). Thus, objectives and sub-objectives are an integral part of the SEA decisions-making structure (Fischer 2007; Pope et al. 2004; Sheate et al. 2001), and represent a hierarchy or value tree of EI agenda to be achieved (Keeney and Raffia; Keeney 1992). Different hierarchies of environmental objectives and indicators in the PPP document are deemed to represent opportunity spaces of different strategic weights, in view of their influential contribution towards the consideration of environmental concerns into planning processes (Kontio et al. 2005). Therefore, a higher-level objective provides an opportunity space and decision-making capital that could be spent and spawned downwards to the lower level or tiers of objectives, reflecting tiered decision-making dynamics within an SEA-PPP process. Moreover, higher tiers of decision-making normally provide a framework for formulation and evaluation of lower tier PPPs and projects (Fischer 2006; ODPM 2005). Environmental indicators also reflect usage of decisional opportunity space and Palerm et al. (2007) underpinned this notion by acknowledging that environmental performance indicators are a mechanism of EI. This is because indicators have a substantive, iterative, cumulative and synergistic influence in SEA and PPP cycles. For example, the baseline data highlights what SEA objectives and indicators are particularly relevant, resulting in an iterative relationship between SEA objectives, SEA indicators and baseline data (Ibid.).

In this research, the overall decisions opportunity space for EI is therefore conceptualised as the aggregation of all the decision windows at the various levels and stages of an SEA process in the “blackbox”. Therefore, the utilization of each space is demonstrated in terms of the final set of environmental objectives and indicators stated in an environmental or SEA report of a PPP subjected to an SEA. OSPA considers the totality of explicit environmental objectives, indicators and targets in the SEA report as an output of deliberate decision-making (Petts 2003; Diduck and Mitchell 2003; Fitzpatrick and Sinclair 2003); and the environmental objectives and indicators considered a currency of EI. Furthermore, it has been suggested that Environmental Assessments are used as instruments to bring environmental objectives into line with those of sustainable development, as well as achieving EI (Fischer 2007). In conclusion, OSPA is premised on the understanding that an evaluation of PPP environmental objectives and indicators will reflect the extent to which the decision-making opportunity for achieving EI has been fully exploited. Such an analysis, however, does not explore the multi-dimensional and eclectic nature of the decision-making process. Neither does it distinguish between the different weights and values inherent in each environmental objective. It must be noted that the attempt to quantitatively measure EI will result in a relative indication because the absolute nature and content of EI is indeterminable.

OSPA evaluation framework

To evaluate the extent of EI as reflected by the environmental objectives and indicators outlined in the SEA report, the SMART (*Specific, Measurable, Achievable, Relevant, Targeted*) criteria introduced were chosen as a framework for quantitative evaluation. These criteria were identified based on their recognition as a normative guide to the formulation and evaluation of statements of objectives and indicators (OECD 2004; Scottish Executive 2002; Doran 1981). To evaluate statements of environmental objectives, only the SMT criteria were used, because it was deemed not feasible to reliably evaluate the *Achievable* (A) and *Relevant* (R) criteria based on the available documents alone. However, to evaluate the indicators, SMRT criteria were used, because it was possible to evaluate the Relevant (R) factor of the indicator to the environmental objectives and environmental baseline indicated in the SEA report. The SM®T criteria scores were used to calculate various scores for EI, following two different schemes. In the first, the scores for objectives and indicators were considered of equal weight (e.g. OSPA5050). In the second, the environmental objectives and indicators were assigned different weights ranging from 60:40, 70:30, 80:20 and 90:10, respectively. This means that an OSPA6040 score is a result of 60% objective score (SMT) plus 40% indicator score (SMRT).

Data collection and processing

To collect data on EI, the following steps were followed:

1) Ratio of environmental objectives against all objectives of the PP was calculated. This score was denoted as TSs, representing the *Theoretical Space*;
2) Within the stated SEA objectives, ratio of environmental objectives to overall SEA/SA objectives was calculated. This score was denoted as SSs, representing the *Substantive Space*;
3) Statements of environmental objectives in the SEA Report were identified and tallied (TS scores) against the environmental themes found in Annex 1 of the SEA Directive, herein conflated into nine[7] themes only i.e. biodiversity, air (noise), water, land use and soils, health (and population), climate, material assets, culture, heritage (and landscape), energy (and transport).

[7] To reduce the 13 into 9 themes, similar environmental themes were put together e.g. biodiversity represented both flora and fauna, and land use included soils. This was done for convenience of gathering data.

4) The environmental objectives in the SEA report were evaluated according to SMT criteria; whilst environmental indicators evaluated according to SMRT criteria (see Box 3). Several combinations of EI scores were done (Table 2.4) in an attempt to find which would have the strongest correlation with SEA elements and SEA scores.

Box 3: Criteria to guide quantitative evaluation of statements of environmental objectives and indicators using the S, M, R & T elements	
Score	**Criteria**
3	SMRT element is adequately and precisely stated and meets all expectations
2	SMRT element is present but not fully elaborated, therefore, below good practice; not satisfactory
1	SMRT element is only slightly mentioned; is poorly elaborated or only alluded to; poorly stated and provides inadequate information
0	SMRT element is lacking or done in a manner completely not in keeping with expectation; conveys no useful meaning for any use

Data from the quantitative evaluation of environmental objectives and indicators were subjected to an analysis of descriptive statistics using Windows Excel tool. The aim was to establish how reliable the data was in order to determine validity of inferences drawn from them.

Table 2.4: EI scores and their notations

Score	**Notation**
Ratio of environmental objectives in the overarching PP objectives (Theoretical space)	TSs = (no. PP env objectives / total PP objectives)
Ratio environmental objectives to overall SEA/SA objectives (Substantive space)	SSs = (no. SEA env objectives / total SEA objectives)
SMT (objectives) score	OSPA = (S +M+T)/3
SMRT (indicators) score	OSPA2 = (S + M +R +T)/4
Ospa5050	Ospa5050= (OSPA + OSPA2)/2
Ospasum	Ospasum = (TSs + OSPA)
Ospaprod	Ospaprod = (TSs x OSPA)
Aggregated EI score	Ospaagg = (TSs+SSs+OSPA)
Weighted EI scores	OSPA60:40, 70:30, 80:20 and 90:10

2.5 Sensitivity analysis

A sensitivity analysis is the study of how a model output varies with changes in the model's inputs (Vester 2007; Ulrich 2005). It consists of recursively varying the values of the parameters and input variables over a range and observing the effect on results and model performance. The analysis is underpinned by mathematical models defined by a series of equations, input factors, and variables aimed at characterizing the process being investigated (Vester 2007). While not perfectly representative, modelling of complex phenomena is compelling because it is cost-effective, faster, more practical than experimenting, benign and can allow for testing under various conditions, and with alternative interventions (Smith 1999). Within the context of the dissertation, sensitivity analysis was applied to enhance the understanding of interactions among the elements within an SEA system, and therefore to test the second SEA definitional claim, i.e. that SEA behaves "systematically" in achieving EI.

More in detail, it was applied to simulate, explain and understand the dynamics inherent in a systematic SEA process. Sensitivity analysis can determine the model resemblance with the process under study; quality of model definition; interactions between variables; factors that mostly contribute to the output variability; and input factors for which the model variation is maximum or optimal, and; instability regions within the space of factors for use in a subsequent calibration study (Vester 2007; Ulrich 2005). Therefore, a sensitivity analysis exercise provides opportunity for reducing common failures in errors of logic in dealing with complex systems (see Vester 2007; Dörner 1996) such as SEA. The common failures are false description of goals, one-dimensional analysis of situations, irreversible fore-grounding, neglected side-effects and over-steering. Consequently, explanatory knowledge can enhance understanding of SEA dynamics, and promote theory-building by:

- Avoiding non-systemic goal setting and one-dimensional analysis of SEA;
- Avoiding irreversible foregrounding, which means insisting on single points of emphasis initially acknowledged as correct, while neglecting other equally important elements;
- Enhancing the unpacking and picking up of relationships and non-visible threads, particularly those not revealed by qualitative-type research approaches.

The SEA elements, interchangeably referred to as variables in this method, are quantities that can change, expressing objective facts or values of a quantitative or qualitative nature, used to reveal the cybernetic dynamics of a system. The sensitivity analysis was applied using the Sensitivity Model developed by Prof. Vester (Vester 2007). It consists of three recursive levels of analysis (Ibid.):

- Cybernetic systems description (data collection and aggregation);
- Cybernetic systems interpretation (understanding the network, e.g., in terms of the influence table (*Characterisation of influence and Index of influence*));
- Cybernetic systems evaluation (understanding the need, consequences, and risks of interventions (*Systemic role*)).

In practice, to create a sensitivity analysis model, three stages are needed (Vester 2007; Ulrich 2005). First, a system is described and constantly updated. Second, a set of relevant variables and parameters[8] representing the system are identified and defined. Third, an influence table in which impact relationships between various system variables is established. Further introductory details on the procedures in a sensitivity analysis are provided in Annex 10. Following system description stage, simulation of various scenarios is done. The simulation results of the Sensitivity Model Prof. Vester are an IF-THEN type of policy scenario exploration (Vester 2007). This means that if the prescribed conditions and variables hold, then the following is likely to develop. Figure 2.2 summarises the key recursive stages of Prof. Vester's Sensitivity Model. A fundamental assumption underlying the application of this model is that SEA processes can be described and modelled by applying circular causal logic, i.e. feedback thinking (Ulrich 2005). The Sensitivity Model Prof. Vester has been successfully applied for over 30 years in the fields of management and technical consulting, business strategies, mediation, risk management, traffic planning, town and regional planning, scientific research and education (Vester 2007). Although other modeling software exist such as Vensim and STELLA, the Sensitivity Model Prof. Vester was selected because it offers the following advantages:

- It is user-friendly and allows trans-disciplinary groups of experts to build a common language as opposed to the prevalent jargons of specific areas of expertise;
- It offers the opportunity to repeat simulations of the same partial scenario under different conditions and compare the different results;

[8] A parameter is herein refers to a quantity that defines a certain characteristic of systems' variable

- The model’s algorithm is based on table functions that allow non-linear relations, and the application of fuzzy logic that recognizes limits and threshold values, as they occur in reality;
- The model’s assumption based on the application of circular causal logic, i.e. feedback thinking, appropriately fits the rationale underlying this research.

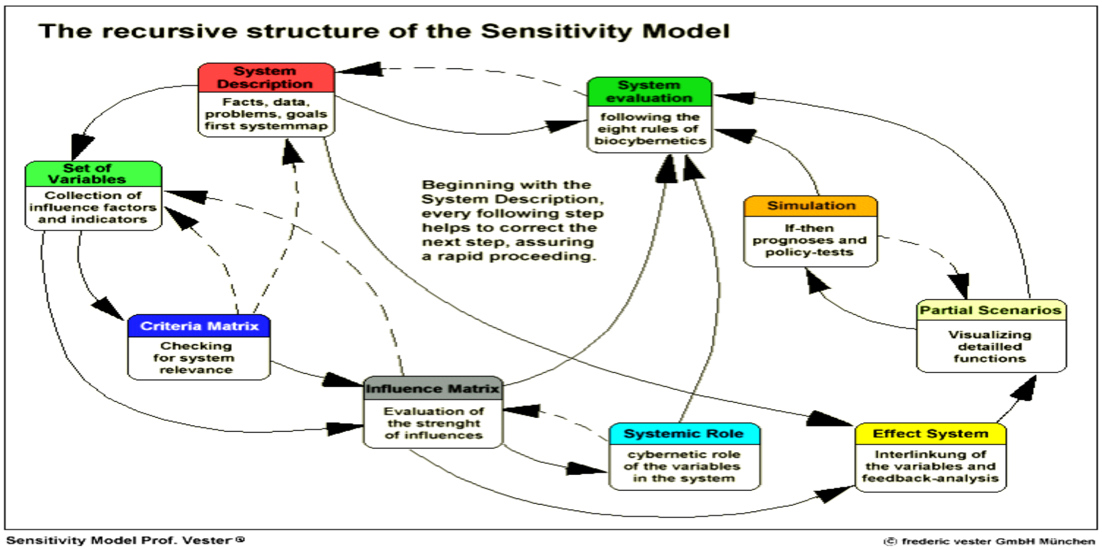


Figure 2.2: Recursive structure of the Sensitivity Model (source: Vester 2007)

Collecting data for sensitivity analysis

To delimit the SEA system, a structured matrix questionnaire (see sample in Annex 11) was sent to three UK SEA experts; i.e. a researcher, an administrator and a practitioner, to balance opinion among these three areas of expertise. They were identified based on the IAIA UK membership list, provided by the IAIA (see section 2.3). The questionnaire matrix proposed SEA elements to be used in the Sensitivity Model, distilled from the SEA literature. The elements generally depicted the procedural, substantive and context elements of the UK SEA system designed to deliver EI, as explained in section 4.4. The three matrices resulting from the three completed questionnaires were used as data input into Prof. Vesper’s Sensitivity Model. A total of 15 scenarios depicting various SEA system settings of interest were built and simulated. The scenarios were developed to narrowly focus on sub-systems of potential influence and leverage, identified from the results of *Characterisation of Influence*, *Index of Influence* and *Systemic Role* of the SEA process. The parameter settings for SEA elements (variables) ranged from Very Low to Optimum according to the indicative classification in Box 4. The term parameter refers to the setting of an aspect of SEA element according to the indicative author’s classification of convenience in Box 4. To undertake a simulation, an element's parameter is set at a range between 0 and 30, corresponding to the given classification, with 15 at the medium level, and all other ranges within the continuum. The classification "Very low" means the element is performed or exists at its lowest potential; whilst the classification "Optimum" means it is carried out according to best practice or exists at its highest potential, in case of context or output elements.

Box 4: Classification of parameter ranges

Parameter range	**Classification**
0 - 5	Very Low
5 - 10	Low
10 - 15	Lower medium
15 - 20	Upper medium
20 - 25	Sub-optimum
25 - 30	Optimum

Simulations were run to between the 3rd and 15th periods, each period representing an iteration of the SEA process; the 3rd being non-empirically selected as the lowest number of iterations during an SEA process and 15th, the highest. Some simulations were more general and of an exploratory nature, while others were focused on key elements of interest identified from the results of cybernetic evaluation. The variable Monitoring and Evaluation was lagged by one loop to show that its effects are felt one cycle later. Some simulations were stopped as soon as a steady state was reached, or an untenable result had been reached. For example, when all variables fall to very low by the third period, then there was no need to continue the simulation even though the curves may have picked up and risen to optimum levels, in later periods. This is because in reality, such a trajectory would not be knowingly pursued. Even if the trajectory provided optimum results in the long run, this research assumed that it would be irrational to follow such a path, unless the very low EI occurred within insignificant time periods. Results of sensitivity analysis are presented in Chapter seven.

2.6 Research analytical framework

The aims of this research analytical framework (subsection 2.6.1) is to present criteria by which the research questions and objectives can be addressed. To enhance this, the criteria followed to assure the validity of research results within the conceptualisation of the research design is also presented (subsection 2.6.2).

2.6.1 Analytical approach

The research analytical framework is based on criteria of comparative analysis of the SEA elements mainly according to four factors. First, the strength and significance of association of SEA elements and EI as indicated by Spearman's coefficient and Kendall's_tau b coefficient, are compared. Second, the generated data on descriptive statistics indicating the reliability of the quantitative data are compared. Third, the relative interaction of SEA elements among themselves, in delivery of EI, as depicted by cybernetic evaluation data and the simulation graphs, are compared. Fourth, the UK SEA experts' opinions on application of quantitative approaches in SEA and EI, as captured in questionnaire survey data, are compared. The comparison entails relative consideration in terms of which element has a higher or better score or exhibits higher curve in the graphs. Comparing the above factors based on results from the various methods provides a common thread for addressing the research questions and objectives. Figure 2.3 depicts an overview of the analytical framework, followed by detailed explanations.

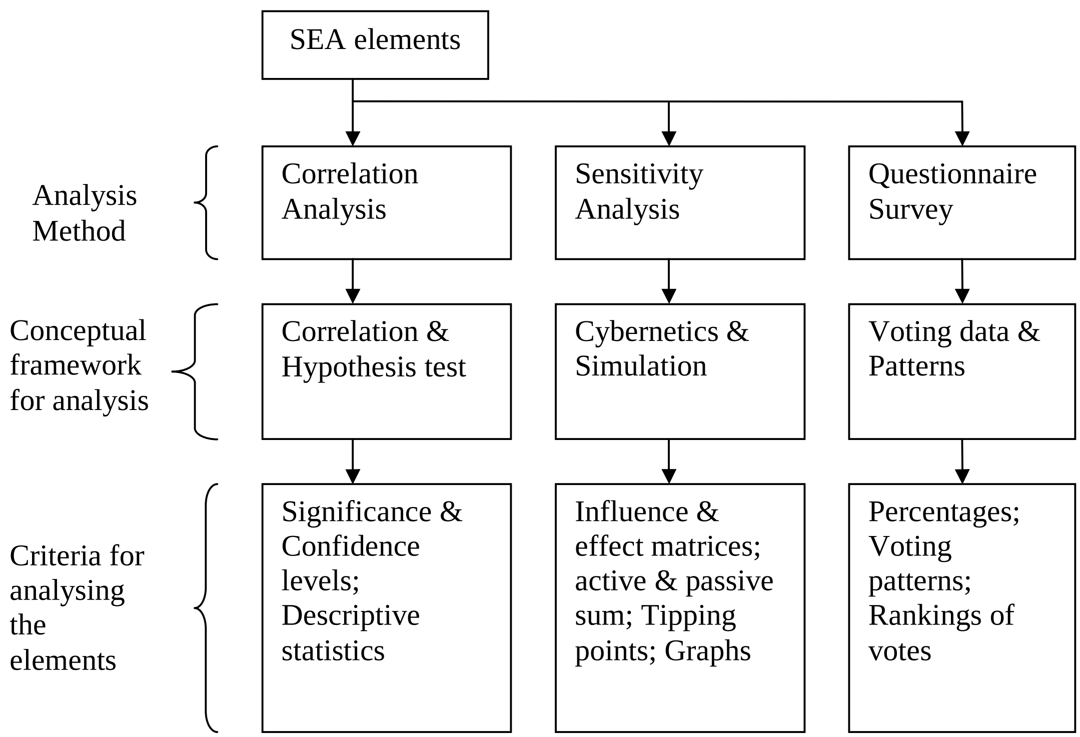


Figure 2.3: Analytical framework showing the approaches and criteria used in analysing results from the various methods

Correlation analysis

Correlation data was analysed and compared in order to identify which elements have weak, medium or strong correlation; the direction of correlation whether positive or negative; and establish the level of statistical significance and confidence. Elements exhibiting significant correlations at levels at 99% and 95% were identified as this indicated that the probability the association existed was almost certain, and relatively more reliable than correlations not significant and below 95% level. In contrast, elements with very low correlations e.g. below 0.3, were considered to be relatively improbable to have the hypothesised effect. Among correlation scores of same significance levels, higher ones are taken as indicators for stronger association. Further, analysis involved the counting of relative associations of significance between elements. For example, if an element registered more significant correlations relative to the other elements, then it was considered relatively more important in determining SEA and EI scores than an element of lower number. Where the direction of correlation was negative, the level of statistical significance was considered in order to determine how much weight to assign the association.

Descriptive statistics

The SEA elements were compared based on the descriptive statistics of the data generated from quantitative evaluation of SEA procedural elements and their output, and EI. Descriptive statistics are used to describe and summarise a set of data e.g. in terms of data spread and central tendencies, before conducting further analysis or comparisons (Hinton 2004). The generated descriptive statistics were evaluated using a simple Multi-criteria Analysis framework in order to establish which elements had the most reliable data based on the best of the mean, standard error, standard deviation and confidence interval scores. The standard deviation is a measure of deviation of a score from the mean in a set of scores. The standard error indicates by what margin a method of measurement or estimation has differed from the true standard deviation of the sampling distribution associated with the estimation method. A confidence interval is the interval estimate within which there is 95% chance that a parameter, in this case the mean of the population, will lay. The generated descriptive statistics are presented in Chapter six together with results of the Multi-criteria Analysis, in which the best relative data for a parameter was assigned rank 1 while the worst rank 9. Therefore, the data was ranked according to following criteria:

- Mean: Highest score (best) ranked 1 and lowest (worst) ranked 9;

- Standard error: Lowest (best) ranked 1 and highest (worst) ranked 9
- Standard deviation: Lowest (best) ranked 1 and highest (worst) ranked 9
- Confidence level: Lowest (best) ranked 1 and highest (worst) ranked 9

Cybernetic data and graph tipping points

Within sensitivity analysis, the comparative analysis of SEA elements was done from two perspectives: cybernetic data and simulation graphs. The cybernetic data (Active Sum (AS) and Passive Sum (PS)), indicating the relative numerical strength of various effects exerted by the elements, was compared. For example, an element with a higher AS has greater influence in the system than one with a lower AS. By comparing these numbers, it is possible to analyse and categorise the SEA elements in terms of their relative influence and effects within the SEA system, in relation to EI delivery. This is enhanced by the graphical distribution of the elements based on derivatives of their AS and PS scores along the four apices of a graph, representing active, reactive, critical and buffering points. The graphs generated from simulating how elements behave in time, relative to each other, allowed a comparative analysis of relative tipping points, curve gradients and curve trajectories. Comparing the graphs allowed for a visual comparison of the dynamic relationship in terms of interplay between and among SEA elements, in achieving EI. From observing the graphs, an element can be traced relative to others, and inferences on how its behaviour changes, determined. Steeper gradients reflect strong influence, while flat curves reflect consistent relative influence.

Percentages

Within the questionnaire survey, the percentages and distribution of UK SEA experts' votes for various SEA elements under various themes were compared. For example differences in respondent opinions were considered in percentages and enhanced by descriptive statistics e.g. standard deviation and mean, in order to determine confidence in the readings. The measure of percentages is therefore used to judge relative quantities of opinions.

2.6.2 Validity and reliability of results

Within this quantitative research approach combining several methods, the triangulation of results was applied. Rooted in positivist perspective (Golafshani 2003), triangulation or cross-examination is the application and combination of several research methods in the study of the same phenomenon, leading to enhanced confidence if different methods lead to the same result (Punch 2005; Golafshani 2003; Bryman 1988). Such an approach is appropriate in studying complex phenomenon where methodological concepts are complex and not easily formulated. Its application is expected to reduce common pitfalls in applying quantitative approaches, for example, adding up separate variables in the quantitative evaluation and resulting in smoothed down sets of generalizations (Miles and Huberman 1994p.172). Therefore, more information and greater confidence is introduced into the conclusions as a result of triangulation. In order to enhance the reliability and validity of the results obtained, a set of validity and reliability criteria were followed. Commonly used in quantitative research (Golafshani 2003; Joppe 2000), they were a significant guide and consideration during the conceptualisation of the research methods. The criteria, as suggested by Marshall and Rossman (1989) and Yin (1994) are:

1. *Construct validity*, referring to the establishment of the correct operational measures for the concepts studied. This was accomplished by designing a research framework in which the research questions, research methods and analytical framework are integrated in order to achieve the research aim. For example, it was necessary that the results of the various methods be triangulated, as the complexity of the research topic did not allow for over-reliance of inferences from a single method.
2. *Internal validity*, referring to the determination of causal relationships, whereby certain conditions are shown to lead to other conditions. This was assured in the research through the use of methods in a complementary manner; and facilitated by the use of hypotheses testing, statistical analyses and simulations.
3. *External validity*, referring to the establishment of the domain in which research findings can be generalized, i.e. from a set of results to the definition of a general theory, and vice versa. In this context the samples of UK SEA practice provided the basis for making both the inferences and inductive generalizations about UK and international SEA practice.
4. *Reliability validity*, referring to the absence of random errors of measurement. This criterion was met by using descriptive statistical data e.g. standard deviation, the standard error, as a means to test and confirm data reliability. Furthermore, the triangulation of results from the various methods increased reliability of results. Seeking the opinions of UK SEA practitioners through questionnaire surveys also increased the reliability of the interpretations and recommendations drawn.

Joppe (2000) defines reliability as the extent to which results are consistent over time, and accurate representation of the total population reproducible under a similar methodology. In quantitative research validity determines whether the research truly measures that which it was intended to measure (Joppe 2000); or how truthful the research results are. Normatively, within quantitative research approaches, reliability is largely assured by construct validity (Winter 2000; Wainer and Braun 1998).

PART II.

SEA BACKGROUND

"Nothing in science – nothing in life, for that matter – makes sense without theory. It is our nature to put all knowledge into context in order to tell a story, and to recreate the world by this means"

Edward O. Wilson (1998 p 56)

Chapter 3 SEA Background and Key Claims in SEA Definitions

This chapter is divided into three sections. The first has the objective of presenting introductory information on SEA in terms of its background, evolution, benefits and approaches. The Second presents an understanding of the key claims made in the SEA definitions. The third presents the context within which SEA systematically achieves EI in the UK, and in which the research results and recommendations are to be grounded. To achieve these objectives, literature reviews were conducted using the scholarly SEA literature, government publications and policy documents. The European SEA context, which sets the framework for SEA in the UK, is briefly introduced. Subsequently, SEA and EI frameworks in the UK are presented in more detail, highlighting the legal, policy, and process requirements.

3.1 SEA background, evolution, benefits and approaches

SEA is commonly understood as a decision-making support tool for integrating environmental considerations into PPP-making for sustainable development (Marsden 2008; Partidario et al. 2008; Dusik and Sadler 2004; Therivel 2004; Noble 2002; Fischer 2002). It is described as a flexible tool that can be applied following different forms and adapted to different contexts in order to respond to different needs (Fischer 2006; Joao 2005). Following this flexibility, some authors have likened SEA methodologies to a “cookbook” in which effectiveness is likely to result if an articulated step-by-step approach is followed (Eggenberger and Partidario 2000; Therivel and Brown 1999; Goodland and Tillman 1996). This implies that each step is defined by the existence of a set of procedural, substantive and contextual elements that must be in place, even if broadly, for SEA effectiveness to be achieved (Gazzola 2006; Fischer and Gazzola 2006; Verheem and Tonk 2000; Brown and Therivel 2000).

SEA has been described as a complex and strategic process that should be value-driven, unlike EIA which is mitigatory and impacts-driven (Partidario and Arts 2005; Therivel and Partidario 1996). It considers the intrinsic values and contents of PPPs and of the decision-making context in which they are formulated and implemented (Bina 2003). The aim is to ensure that environmental considerations are integrated on par with social and economic considerations, thereby enhancing sustainable development (Henriques and Richardson 2004). This scope of SEA is facilitated by the existence of a framework that enlists the principles and objectives of sustainable development (Gibson 2007, 2006; ODPM 2005; POST 2005). Such frameworks for sustainable development provide guidance for an equitable and balanced consideration of environmental aspects in respect to social and economic ones (Gibson 2007, 2006; DETR 1998; Therviel and Partidario 1996).

SEA can be applied to at least three tiers of decisions-making, i.e. to policy, plan and programmes, following a concept called "tiering" (Fischer 2006; Joao 2005; Therivel and Partidario 1996). This tiering concept represents the inter-linkages between different forms of SEA (e.g. policy, plan and programme). It provides a mechanism for propagating, accounting and reconciling objectives between the different hierarchical decisions-making levels (e.g. national, regional, sub-regional to local) and their associated PPPs and lower-level projects (Fischer 2002; Therivel and Partidario 1996). Through tiering SEA ensures that the environmental objectives at the highest decision- and plan-making levels are consistently applied and substantiated through to the lowest levels (vertical tiering) and horizontally, across similar levels (horizontal tiering) (Joao 2005; Partidario and Arts 2005). SEA is said to be instrumental in terms of its capacity to influence decisional processes and by ensuring that the environment is taken into account (World Bank 2005; Nitz and Brown 2001; Kornov and Thissen 2000; Weston 2000). In order for this to occur, two key principles must be followed i.e. the best environmental or sustainable development option among possible PPPs be identified; and the proposed PPP not just be assessed and analysed, but improved (Joao 2005). A supportive culture, positive attitude and enabling political environment have also been stated as critical to SEA effectiveness (Fischer and Gazzola 2006; Nitz and Brown 2001; Bartlett and Kurian 1999). Examples of other basic elements in effective SEA include (Partidario and Clark 2000):

- Clear requirements (legal, administrative and policy);
- Public participation and stakeholder consultation;
- Well-established SEA processes including main procedural steps;
- Independent oversight and guidelines for practice;
- Support from government and private sector.

Fischer and Gazzola (2006) further found out that effectiveness criteria were not universally valid and that their applicability depended on the politico-cultural, policy and planning contexts of a country. Other factors that can contribute to SEA effectiveness and to the consideration of SEA findings into decision-making include (CEC 2001; Partidario and Clark 2000):

- Clear environmental policy objectives;
- Clear criteria and quality standard frameworks to assess proposal need, justification, and environmental effects;
- Good State of Environment reporting, public interest and NGO involvement; cooperation between stakeholders;
- Well structured planning process, accountability and commitment;
- Resource availability and access to information.

3.1.1 SEA evolution

The term SEA was first used by Wood and Djeddour at a conference in 1989 and subsequently appeared in international journal in 1992 (Dalal-Clayton and Sadler 2005). It emerged based on the realisation that Environmental Impact Assessment (EIA) was inadequate to account for the consideration of cumulative impacts and for ensuring that the environment was systematically taken into account in planning above the project level (Sadler 1998). Thus, SEA was developed to address the weaknesses of EIA by ensuring that important strategic decisions were subjected to an environmental assessment. As a tool, SEA is applied at an early stage in the PPP-formulation process; and at appropriate scale for the consideration of potential cumulative impacts from several projects and other existing PPPs (Marsden 2008; Schrage and Bonvoisin 2008; Joao 2005; Therivel et al. 1992).

Considering environmental issues at strategic levels is not very new. This was already enacted and incorporated into the US's 1969 National Environmental Protection Act (hereinafter NEPA), which formally introduced EIA (Marsden 2008). NEPA required the proponents of development projects and policies that involved US federal land, federal tax dollars or federal jurisdiction to include in every recommendation or proposal for legislation or a major federal action, a detailed statement of environmental impacts (Bailey and Renton 1998). This SEA-like part of NEPA had largely not been tried and tested till the 1990s, when SEA started to evolve as a tool and its adoption increased (Marsden 2008; Caldwell 1998; Buckley 1998). This pick-up occurred following increased global awareness of the need to integrate environmental considerations during PPP-making (Marsden 2008; Noble 2006). For example, at an international level, the World Bank in 1999; the WCED's "*Our Common Future*" report in 1987; and the UNCED’s Rio de Janeiro *Earth Summit* in 1992 and principle 17 of the Agenda 21, calling for the adoption of SEA-like assessments (Marsden 2008; Noble 2002). Since then, SEA requirements have been rapidly introduced and widely adopted by several other countries, international organisations and key international environmental treaties e.g. Ramsar Convention, Convention on Biodiversity and the Millennium Development Goals (Marsden 2008; Fischer 2007; Dalal-Clayton and Sadler 2005; Schmidt et al. 2005). Progressively, lessons have been learnt and drawn from international SEA experience (World Bank 2005; Dalal-Clayton and Sadler 2005; Sadler 2001); and different countries have codified their understanding of the way in which SEA should be applied in ‘Good Practice’ manuals and ‘Handbooks’ (for the UK see ODPM 2005; POST 2005). The idea behind a ‘Good Practice’ manual is to identify a specification for what the best methodology is for any given situation and adaptable to different contexts, rather than being applicable to a particular procedure or set of institutional arrangements only (ODPM 2005; CEC 2001; Sadler 2001). Thus, ‘Good Practice’ provides a benchmark for practice and for quality assurance (Hilding-Rydevik 2003). It “illustrates the basis of effective SEA process, practice and performance” (Sadler 2001 p. 11) and focuses on the explicit discrete conceptual and procedural key processes linked to delivery of environmental protection and sustainable development objectives.

However, the development of an SEA theory distinct from that of EIA was lagging behind; it was described as being poorly developed and inadequately detailed (Fischer 2002; Bartlett and Kurian 1999; Lawrence 1997). It is only relatively recently that an evolution of SEA theory started to take place, with contributions from Fischer (2007, 2003, 2002), Caratti et al. (2004), Nilsson and Jiliberto (2004), Owens et al. (2004), Nilsson and Dalkmann (2001) and Kornov and Thissen (2000). Since, SEA has progressively grown its own distinguishing theoretical, procedural and legal framework in an attempt to separate between EIA and itself (Fischer 2007; Bina 2006; Wood and Djeddour 1992; Lee and Walsh 1992). In this context, SEA’s evolution is reported to have gone through three main chronological phases (Dalal-Clayton and Sadler 2005; Sadler 2001). First, the *formative stage (1970-1989)*, when legal and policy frameworks were established, but followed by limited application of SEA-like procedures. This was followed by the *formalisation phase (1990-2001)*, when countries and international organisations instituted different forms of SEA. Thirdly, the *evolution stage (2001 onwards)*, when legal and policy frameworks for promoting SEA have been widely promulgated.

A fourth phase called "Theory-building" (2002 onwards) can be suggested. This phase focused on examining SEA theory and practice, particularly in terms of the potential advantages of a decision-oriented theory in SEA (see Pischke and Cashmore 2006; Caratti et al. 2004; Kornov and Thissen 2000); and on different SEA procedural aspects, such as public participation and scoping (Petts 2003; Diduck and Mitchell 2003; Fitzpatrick and Sinclair 2003) and SEA follow-up (Partidario and Fischer 2004; Arts and Morrison-Saunders 2004). In terms of SEA conceptualisation, Bina (2003) lists three key development trends:

- Shift from traditional object of assessment of draft PPPs to a more broad assessment, encompassing the view of the policy process and of its political and decision-making dimensions;
- Focus towards the promotion of sustainable development as opposed to mere environmental protection and integration, with emphasis on both, the natural and social sciences;
- Reduced emphasis on the positivist dimension of impact assessment within the overall SEA process, and the increased attention to the formulating stages of strategic PPP-making and to its systematic application.

3.1.2 SEA benefits

It is widely acknowledged that SEA can promote sustainable development by ensuring that environmental sustainability objectives are mainstreamed into PPP-making at the earliest stages possible. SEA achieves this by influencing the context and content of the broader decisions-making processes (Sadler 1999; Lawrence 1997). Furthermore, following Fischer (2007), SEA can provide for:

- A stronger representation of strategic environmental thinking in PPP-making;
- More effective reasoning in decision-making;
- More efficient decision-making; and
- Better support of good governance and sustainable development in decision-making.

Advocates for SEA claim that it provides the basis for arriving at better-informed strategic decisions by assisting the competent authorities with the identification of (Fischer 2007; Cooper 2003; Kjörnen and Lindhjem 2002; Noble 2000):

- Key environmental trends, potentials and constraints that may affect or be affected by the proposed PPP;
- Environmental objectives and indicators relevant to the PPP;
- Measures to avoid and/or mitigate adverse effects, as well as measures to enhance the positive environmental effects arising from the implementation of the proposed PPP;
- Views from relevant authorities, the public, stakeholders, bordering countries (in case of trans-boundary SEA) potentially affected by the proposed PPP;
- Impacts (cumulative, synergistic, secondary, short and long-term, permanent and temporary) related to proposed PPP;
- The consistencies and inconsistencies of the proposed PPP's objectives and options with other relevant strategies, treaties, policies and commitments, to ensure that progress is being made towards the pursuit of a common vision of sustainable development;
- Tiering opportunities, by enhancing vertical and horizontal integration of decision-making from PPPs to projects level, therefore streamlining and strengthening EIA.

In summary, SEA facilitates and enhances the promotion of environmental protection and sustainable development, by acting as an advocacy tool that raises awareness, and enhances the co-ordination, communication and accountability of the PPP-making process (Renda 2006). This promotes education and social learning, leading participants of the SEA process to gather new insights on the procedures and on the substantive matters within the sustainable development agenda (Fischer 2007; Sheate et al. 2000). The enhanced learning about sustainability has been touted to be amongst the most significant impacts of SEA (Fischer 2007; Gazzola 2006; Bina 2006; World Bank 2005; Owens et al. 2004).

3.1.3 SEA approaches

SEA can be applied in two ways: (1) as a stand alone tool that can improve PPPs based on the collection of objective evidence and scientific input; or (2) as an iterative process that is systematically integrated into PPP-making processes (Vicente and Partidario 2006; ODPM 2005; Devuyst et al. 2000; Renton and Bailey 2000). In practice, SEA takes several different forms, for example (Sheate et al. 2003; Sadler and Verheem 1996):

- EIA-based SEA model, whereby SEA is carried out under EIA legislation or PPPs are essentially subjected to EIA procedures;

- Policy-appraisal model or objectives-led, whereby principles of environmental assessment are tailored to the formulation of PPPs through the identification of needs and options for development, which may then be assessed in the context of sustainable development;
- Integrated model or *ad hoc* model, whereby SEA is in effect an element or part of the policy- and plan-making process.

The procedures for EIA-based and policy-based SEA are similar and to a certain extent, depend on scientific surveys and quantitative data approaches. Policy-based SEA, however, depends more on qualitative analysis and subjective approaches that rely on expert opinions and judgements (Sheate et al. 2003). Moreover, policy-based SEA is premised on the strategic nature of policy-making, and represents a top-down approach to decision-making. EIA-based SEA is premised on the steps and procedures of project EIA and on the collection of environmental baseline information, representing a bottoms-up approach (Dalal-Clayton and Sadler 2005; Therivel and Partidario 1996). Finally, the integrated or *ad hoc* model combines the two previous forms of SEA, assessing the PPPs significance against both the sustainability-led objectives and the baseline (Gazzola 2006).

3.2 Key claims in SEA definitions

This section has two objectives. First, present an understanding of the two key claims stated in almost all SEA definitions, according to which 1) SEA achieves EI in PPPs and 2) SEA is a systematic process. A universally accepted definition of SEA does not exist and several definitions can be found in the policy and academic literature and in legal, regulatory and practice documents (Gazzola 2006). Similar in purpose (Therivel 2004), they emphasise different aspects of SEA (see Box 5). Whilst definitions 1, 6 and 7 emphasise the procedural nature of SEA, the rest emphasise the substantive. In a more recent definition, Fischer emphasises governance as a key definitional aim of SEA. He states that SEA is "a systematic, objectives-led, evidence based, pro-active and participative decision-making support process for the formulation of sustainable PPPs, leading to improved governance" (Fischer 2007 p. 14). A common denominator of all of the above definitions is that the systematic achievement of EI is at the core of SEA's definitional, conceptual and purposeful nature. This is well supported in the SEA literature (see for example Sadler 2005; World Bank 2005; Schmidt et al. 2005; Sadler and Verheem 1996; Therivel et al. 1992; Wood and Djeddour 1992).

Subsequently, based on review of available SEA literature, the understanding of EI and of the systematic nature of SEA is presented in more detail in the following subsections.

Box 5: Some commonly used definitions of SEA
1) “a formalised, systematic and comprehensive process of evaluating the environmental impacts of a PPP and its alternatives, including the preparation of a written report on the findings of that evaluation, and using the findings in publicly accountable decision-making” (Therivel et al. 1992 pp. 19-20; Therivel and Partidario 1996). 2) “a systematic process for evaluating the environmental consequences of proposed PPP initiatives in order to ensure they are fully included and appropriately addressed at the earliest stage of decision-making on par with economic and social considerations” (Sadler and Verheem 1996 p. 27; Brown and Therivel 2000); . 3) “a process directed at providing the authority responsible for policy development and decision-making with a holistic understanding of the environmental and social implications of the policy proposal” (Brown and Therivel 2000 p. 184). 4) “a participatory approach for up-streaming environmental and social issues to influence development planning, decision-making and implementation process at strategic level” (Ahmed et al. (2005) on World Bank definition). 5) “Strategic environmental assessment in regional land use planning is a systematic process in the EU Member States, which aims at an optimisation of the integration of environmental policies into decision-making at regional scale of 1: 100 000” (Helbron 2008 p. 1). 6) “evaluation of the likely environmental, including health, effects, which comprises the determination of the scope of an environmental report and its preparation, the carrying-out of public participation and consultations, and the taking into account of the environmental report and the results of the public participation and consultations in a plan or programme” (UNECE 2003 p. 4). 7) “preparation of an environmental report, the carrying of consultations, the taking into account of the environmental and the results of the consultations in decision-making and the provision of information on the decision” (CEC 2001)

3.2.1 SEA achievement of Environmental Integration (EI)

As early as 1975, NEPA defined the environment as inclusive of economic, social and physical environmental impacts and concerns. Herein, the understanding of the term environment is similar to that of the SEA Directive. Thus, it refers to the biophysical environment and to the linkages between the biophysical and the social environments, looking at people's quality of life and economic activity encompassing health and cultural aspects (CEC 2001). Webster (1992 p. 507) defines the term integration as "to make whole by bringing together; addition of parts; well adjusted". Despite its simplicity in definition, in environmental assessment, and more specifically in SEA, EI has proven to be a daunting task that is methodologically insurmountable and impossible to fully achieve (Gibson 2007; Jiliberto 2007; CEC 2001). According to Sheate et al. (2001), EI is bounded by problems associated with the management of change and uncertainty. The challenges underlying the achievement of EI are summarised as follows:

- The sum of the parts is not equal to the whole;
- Integration may mean that a functionally new entity where new relationships are created is precipitated;
- Integration occurs at different levels of decision-making and are not always amenable to measurement; and
- The incomplete knowledge base regarding problems and the inability to comprehend a situation in its entirety makes integration rather difficult to grasp.

In SEA practice, EI is considered a relevant guiding principle in decision-making and PPP formulation (Joao 2005; Therivel 2004; Fischer 2002). Within this context, EI has emerged as the favoured means through which the effectiveness of environmental assessment could be increased and sustainable development promoted (Palerm et al. 2007; Gibson 2006; Kirkpatrick and Lee 1997). SEA is considered an effective tool of choice to integrate the environment at strategic levels; and it is widely believed that the theoretical benefits of SEA centre on the ability of the process to help PPPs reflect sustainable development concerns (Jones et al. 2005; Joao 2005; Eggenberger and Partidario 2000). SEA facilitates EI by disaggregating the components of a whole system into parts that can be individually analysed, and then results brought together (Gibson 2007). In SEA, EI is therefore understood as the process of incorporating environmental values into PPP formulation and decision-making (Vicente and Partidario 2006; CEC 2001). Environmental values, either individual or collective, are an expression of an attitude, perception or preference for the state of the bio-physical or built environments, within which humans interact (Sheate et al. 2003). The term “integration” has a variety of meanings within the environmental context. Scrase and Sheate (2002) identified 14 types of integration, while Lee (2002) identified three understandings of integration within environmental appraisal, as follows:

- *Vertical integration*, or tiering, i.e. the linking of separate impact assessments at different levels of decisions-making and planning e.g. of PPP and project formulation, and hierarchical tiers of decision-making;
- *Horizontal integration*, i.e. the linking of different types of assessments at same hierarchical level e.g. economic, social and environmental, into a single overall assessment;
- *Integration of assessments* into decision-making i.e. integrating findings into different stages of single PPP formulation processes.

Understanding the term EI also encounters challenges. For example while “EI” is also expressed in terms of “environmental consideration”, the matter of “consideration” is largely left open to interpretation (Gibson 2007; Pölönen 2006). Furthermore, it is not clear when a satisfactory achievement of EI has been reached. However, SEA is said to facilitate the consideration of the environment by indicating and communicating environmental values during decisions-making processes (Sheate et al. 2003). In this context, the explicit recognition of environmental concerns is considered a prerequisite for EI to be attained, with environmental statements, objectives and indicators used as a basis for achieving EI (Gibson 2007, 2006; Palerm et al. 2007; CEC 2001). This key role of environmental objectives and indicators makes them ideal as evaluation factors for EI, as illustrated in subsections 2.4.2 and 2.4.3 of this dissertation. Herein, EI is specifically considered as the articulated presence of environmental values and targets in decisions and decisions-making processes, in a manner that explicitly recognises and addresses the intended environmental issues. Thus, EI is not merely about mentioning or raising the profile and awareness of the environment (Sadler 2005; Bojö et al. 2004); it is about providing coherent intention and/or plans to deliver the stated environmental objectives and to implement them (Feldman and Khademian 2005; Moore 1995; Brunson 1985), as is presented in the SEA report.

3.2.2 SEA as a systematic process

The second claim analysed in this research is that SEA is a "systematic process". Unlike on EI, the literature on the systematic nature of SEA is relatively scanty. Nevertheless, three key understandings of this systematic nature are depicted in the literature. The first highlights the procedural nature of SEA suggesting that SEA has defined stages and tasks that should not to be changed arbitrarily (Fischer 2002; Partidario 1996; Sadler 1996; Wood 1995). This depicts a methodical, progressive and planned framework in which SEA is applied, whereby to every SEA task a corresponding planning task exists (ODPM 2005; Dusik and Sadler 2004; REC 2001; Slootweg et al. 2001). The second understanding refers to the scope of application, according to which SEA is a system-oriented approach, taking a wide range of cumulative and indirect effects into account (Therivel 2004). Also, a wide range of thematic issues encompassing a sector (e.g. energy, transport, water, biodiversity, health) or geographic range (e.g. district, region) can provide the basis for a system of issues.

Finally, the third understanding is of a functional nature, which is characterised by the dynamic inter-linkages between SEA elements, with positive and negative feedback loop mechanisms (Jessel 2005; Therivel 2004; Noble 2000). In terms of its procedures, SEA has been described as "…an iterative assessment with the plan and/or program making process" (Gazzola and Maristella 2005 p. 129). Therivel and Partidario (2004 p. 187) emphasise this systematic nature by stating that SEA "should be based on a systematic methodology, possibly linking objectives, indicators, baseline analysis, impact predictions, mitigation and monitoring". In this context, SEA is perceived to comprise positive and negative feedback[17] loops that influence each other, as integral parts of a wider dynamic and iterative process (Dalkman and Bongardt 2004; Partidario 2000; Kornov 1999). Such systematic process approaches have been frequently applied in the development of engineering methods as an integral part of process optimisation (Weigt and Seidel 2004). In this sense SEA being a systematic process implies that the concept of a streamlined methodological framework is an opportunity to optimise delivery of SEA products and outcomes, herein particularly EI.

The reviewing of SEA reports and the corrective actions emanating from monitoring and evaluation measures are examples of such iterative feedback loops (Partidario 2000).

[17] Feedback is both a mechanism, process and signal that is looped back to control a system within itself, thereby facilitating self-regulation (Vester 2007)

Ultimately, feedback mechanisms portray reflexive governance[18] where iterative problem-handling processes for diverse knowledge, values and resources of influence, are promoted (Elling 2008; Voß et al. 2006). Therivel (2004 p. 77) also mentions the concept of iterative feedback in SEA, thus:

> "…the first list of SEA themes, objectives, indicators should be treated as draft and as part of feedback cycle: as more baseline data are collected and problems identified, that should help focus the objectives on the issues of greatest concern, and in turn, this should help to focus and restrict the collection of further baseline information".

The understandings of SEA systematic nature presented are complimentary because the procedures are inextricably linked to functions; and substantive SEA outputs such as EI have process implications (Gibson 2007). Whilst the first two understandings have been widely researched, to date, the system "function" understanding has received limited attention (Fischer 2002). Negative feedback loops help to maintain stability in a system while positive feedback loops amplify possibilities of growth and divergence, giving the system the ability to access new points of equilibrium (Vester 2007). As a rational[19] process, SEA uses a systematic framework to optimise the delivery of its outputs (Pischke and Cashmore 2006; Caratti et al. 2004), i.e. within the context of this thesis, EI. However, when operating in complex systems[20] such as SEA, predictions and outcomes are difficult to anticipate or manage. Hence, an enhanced understanding of system dynamics and pattern behaviour in order to refine SEA application is required (Rehani 2002; Serafin et al. 1992). This is because complex systems have generally and often been plagued by logic of failure by the following typical errors (Vester 2007; Dörner 1996):

- False description of goals – e.g. wrong identification of the leverages to tweak in an SEA system in order to improve delivery of EI;

[18] Reflexive governance relies on feedback and is a notion that re-conceptualises society's management through iterative spirals of experimental problems, solutions and learning, as opposed to heroically and directly conquering all challenges (Voß et al. 2006).

[19] The term "rational" refers to a decision-making process that pursues logic of consequences and attempts to maximise the benefits an individual can gain from their choice(s) (see Jiliberto 2002; Kornov and Thissen 2000; Zey 1998).

[20] A complex system is one which behaves differently from the sum of its parts (Vester 2007; Rehani 2002)

- Uni-dimensional analysis of situations – e.g. approaching SEA effectiveness from single stages, such as Scoping or Public Participation, instead of a wholesome perspective of inter-linkages within the system;
- Irreversible foregrounding – e.g. current perspectives locked in past successes and failing to reflexively update with newer knowledge;
- Neglected side – effects (reality picking) e.g. by focusing on specific singular aspects of interest, sight is lost of other potentially significant elements;
- Over-steering, e.g. where in the absence of negative feedbacks to instill self-correction, certain elements are allowed to have effects that make the system over-develop.

3.3 SEA systematic delivery of environmental integration (EI)

A review of SEA literature revealed that while SEA procedural stages for providing feedbacks exist, how well these interactions systematically played out to deliver EI has not been explored and documented. Feedback mechanisms in SEA can occur in several ways. For example, SEA procedures can be iteratively applied and reviewed, until deemed satisfactory, in terms of quality assurance and legal compliance (Jessel 2005). This can occur at the initial stages of SEA, where the SEA scope and definition of environmental or SEA objectives can go through refining until appropriate ones are formulated (Jessel 2005; Jiliberto 2004). The SEA report repeatedly reviewed by a competent authority and/or stakeholders through consultations, can as well lead to adjustments of the SEA process, its output(s) and scope (Fischer 2007; Therivel 2004). Through iterative public participation and consultation, transparency of the process as well as opportunity for necessary feedback in revising and improving the SEA process and its outputs, is assured (Therivel 2005). Although opportunities for feedback mechanisms can occur throughout the SEA process, monitoring and evaluation and SEA follow-up stages offer yet another opportunity. They are already acknowledged as formal stages for feedbacks and quality assurance (Partidario and Arts 2005; Morrison-Saunders and Arts 2005), and are therefore potentially effective entry points for enhanced SEA feedback loops.

Following postmodernist thinking, for SEA to achieve EI in strategic planning and decision-making, it must communicate well, act strategically, ensure a long-term perspective and account for the socio-political dimension of environmental protection and sustainable development (Gibson 2006; Blanco 2005; Therivel and Partidario 1996). SEA therefore improves the consistency and quality of decision-making by introducing decisional criteria that allow EI to occur (Kornov and Thissen 2000; Brown and Therivel 2000). This is done through windows of opportunity, which define the way in which SEA can achieve EI (World Bank 2005; Caratti et al. 2004). Windows of opportunity for EI can occur in the following ways:

- Via SEA's capacity to influence decision- and PPP-making contexts (Vicente and Partidario 2006; Dalal-Clayton and Sadler 2005; Partidario 2004; Therivel 2004; Sheate et al. 2003; Bina 2003; Nilsson and Dalkmann 2001; CEC 2001);
- Via SEA's procedures, which help decision-makers identify strategic options that meet both environmental aims and the integration of environmental concerns into PPPs (Sheate et al. 2003; Wood 2002; Noble and Storey 2001; Brown and Therivel 2000; Marsden 1998);
- Via SEA tiering, which integrates and propagates results from different assessments - comparing and weighing diverse impacts to make informed trades-off within vertical and horizontal decision-making levels (Therivel 2006); and
- Via SEA's systematic and iterative nature, bringing greater knowledge and fit for purpose information to decision-makers and those involved in the process. This challenges their established organisational culture, values and routines (Fischer 2007).

In a European report published in 2001, it was concluded that SEA's capacity to achieve EI in strategic planning was difficult to evaluate (CEC 2001). This was aggravated by difficulties in predicting environmental effects at the most strategic level, and in setting up quantifiable environmental targets and objectives. Nevertheless, the CEC (2001) report recommended that the environment be integrated explicitly, rather than implicitly, as trade-offs can be done in a more transparent way. This entails explicitly highlighting environmental problems, opportunities and objectives (CEC 2001), accounting for natural capital depletion (Goodland 1997) and maintaining the "source and sink" functions of natural systems (Sadler 1999; Sadler and Verheem 1996). Furthermore, it has been stated that in order for SEA to assist the decision-making process design more sustainable policies and strategies (Therivel and Partidario 1996), clear benchmarks against which SEA objectives and criteria can be measured, are required. Further, the CEC (2001) depicted three models through which EI may be achieved, summarised as follows:

- *Constitutional/legislative model*: relying on specific legal provisions for environmental protection and integration in a country's constitution;
- *Process/strategy model*: relying on coordinated, government-led strategy for EI e.g. Greening Government, Sustainable Development Strategies, Local Agenda 21 and Land Use Planning;
- *Ad hoc Institutional model*: relying on approaches that may exist outside of a centrally coordinated strategy e.g. Audit Committees/Independent Auditor, National Commissions/Councils on Sustainable Development, Round Tables.

Prior to the CEC (2001) report, de Groot (1992) had presented a conceptual framework for EI. It focused on the functions that the biophysical environment provided to humans, and on the assessment of their value for supporting human-related activities. Wilkinson (1998) later presented three pathways through which SEA can achieve EI. These are:

- *Top-down integration*: binding frameworks constraining the actions of sectoral departments, often led by a strong environment ministry reviewing and regulating the environmental performance of other departments;
- *Bottom-up integration*: where integration occurs independently within sectoral departments through a gradual process and where the environment ministry can only persuade or influence; and
- *Intermediate steps*: where sectoral departments face increasing constraint, as they are required to apply 'integrative mechanisms' such as SEA or environmental auditing and reporting.

Other characterisations of EI exist, for example (Kessler and Abaza 2006; Abaza and Hamwey 2001; Eggenberger and Partidario 2000):

- *Substantive:* the integration of physical or biophysical issues with, for example, social, economic, health, risks, bio-diversity and climate change;
- *Methodological:* the integration of environmental, economic and social impact assessment approaches;
- *Procedural:* the integration, co-ordination, co-operation of environmental, social, economic planning/assessment, spatial planning and approval/licensing processes;

- *Institutional:* the provision of capacities to cope with the emerging issues and duties, e.g. through definition and establishment of interventionist institutions and organizations to ensure integration; and
- *Policy:* the integration of various guiding principles in planning and PPP formulation, e.g. the integration of sector regulations, strategies and measures.

To date, several studies exist in which the impact of SEA on decision-making has been studied empirically and several evaluation frameworks proposed (Aschemann 2004; Fischer 2002; Therivel and Minas 2002). In summary, this section has presented various and somewhat overlapping approaches and mechanisms, through which SEA can achieve EI. It has been stated that whatever mechanisms are used to achieve EI, the process and output must involve explicit statements of the environmental values and objectives to be incorporated into the PPP (Gibson 2007; CEC 2001). Nevertheless, challenges associated with SEA attainment of EI exist (Jiliberto 2007). For example, the SEA process does not have a standardized decision-making process; SEA does not have a clear target from which to ensure EI; there are no universal standards for EI; and EI is largely context specific (Audouin and Lochner 2000). However, within the context of this dissertation, EI has been defined and its context within the SEA Directive provides a boundary within which EI can be evaluated.

3.3.1 The SEA Directive: a framework for systematic EI

The EC's so-called SEA Directive 2001/42/EC (hereinafter the SEA Directive) was adopted on 27th June 2001. It aims 'to provide for a high level of protection of the environment and to contribute to the integration of environmental considerations into the preparation and adoption of plans and programmes (hereinafter PPs) with a view to promoting sustainable development' (Art. 1) (EC 2003). It sets out what Member States are formally required to do to give this process legal effect and stipulates the procedural and substantive requirements for SEA (Jackson and Illsley 2007; Albrecht 2005). The SEA Directive applies to all relevant PPs whose formal preparation began after 21st July 2004 and defines "environmental assessment" as a procedure comprising (Albrecht 2005):

- Preparing an Environmental Report on the likely significant effects of the draft PP;
- Carrying out consultation on the draft PP and the accompanying Environmental Report;

- Taking into account the Environmental Report and the results of Consultation in the decision-making process;
- Providing information when the PP is adopted and showing how the results of the environmental assessment have been taken into account.

The SEA Directive stipulates that SEA shall be carried out for all PPs, which are prepared for agriculture, forestry, fisheries, energy, industry, transport, waste management, water management, telecommunications, tourism, town and country planning or land use and which set the framework for future development consent of projects. From the 21st July 2004, EU member states were required to transpose the SEA Directive into national law, by developing their own detailed procedures for implementing and applying the requirements of the SEA Directive according to their planning and decision-making contexts (Marsden 2008; Albrecht 2005; ODPM 2005). The result to be achieved by the SEA Directive is binding upon every member state, according to Art. 249 EC Treaty, but leaves the national authorities the latitude of form and methods when transposing it into own requirements. The SEA Directive is by nature a procedural law as most of the provisions are about SEA procedures (Albrecht 2005).

In Preamble (19) The SEA Directive recognises that in order to avoid duplication of assessments, Member States may provide for coordinated or joint procedures fulfilling the requirements of the relevant Community legislation. Several European requirements and laws, with obligations to carry out assessments of the effects on the environment, are recognised by the SEA Directive. These include the EC EIA Directive (85/337/EEC), the Water Framework Directive (2000/60/EC), the Nitrates Directive (91/676/EEC), Waste Water Framework Directive (75/442/EEC), the Air Quality Framework Directive (96/62/EC), the Habitat Directive (92/43/EEC) and Wild Birds Directive (979/409/EEC). While Art. 6 of the EC Treaty obliges the EC, the SEA Directive obliges the member states to include ‘Environmental protection requirements’ in the European Community policies and measures and members states PPs, respectively (Marsden 2008; Albrecht 2005). Furthermore, the SEA Directive adopts and links to key environmental and sustainable development principles that are codified in other laws, including for example (Kläne and Albrecht 2005; Feldmann et al. 2001):

- Principle of precaution and prevention, Art. 174 para 2 EC Treaty;
- Principle of sustainable development, Arts. 2 and 6 of EC Treaty;

- Integrative environmental protection in sections 3.2 and 5.3 of the EU 6th Environmental Action Plan;
- Public participation and access to information on the environment, based on the Aarhus Convention (see Marsden 2008);
- The United Nations Economic Commission for Europe Convention on Environmental (UNECE) Impact Assessment in a Transboundary Context of 25 February 1991, which applies to both Member States and other States, encourages the parties to the Convention to apply its principles to plans and programmes (Albrecht 2008);

Several SEA and EI policy documents exist at the EC level, which set the policy framework for both SEA and EI (Marsden 2008; Albrecht 2005). The high level of environmental protection referred to in the SEA Directive's objective is an EC policy aim that is written down in Art. 174 para 2 of the EC Treaty (Marsden 2008). Furthermore, the Göteborg European Council of June 2001 and the Laeken European Council of December 2001, discussing the future of Europe, both adopted the principle of impact assessment as a critical component of PP formulation, creating a link to SEA. The principle of sustainable development and public participation/consultation are cited in Recital 2 and 17/18 of the SEA Directive, respectively, underpinning a favorable policy environment towards SEA and EI (Kläne and Albrecht 2005). The SEA Directive preamble makes key references to 'environment Articles.' i.e. Art. 6 and Art. 174 of the EU Treaty; the Environmental Action Plan[21] (e.g. the Sixth Environmental Action Plan 2001-2010) and the Convention on Biodiversity (Dalal-Clayton and Sadler 2005). The SEA Directive is therefore a significant umbrella law from which the UK SEA practice is buttressed and directed.

3.3.2 SEA and EI in the UK: legal and policy frameworks

In the UK, the SEA Directive was transposed into law in 2004 through The Strategic Environmental Assessment Regulations (Statutory Instrument 2004, No 1633, The SEA Regulations). The UK, a parliamentary democracy with a symbolic Monarch as the Head of State, has devolved certain political and policy-making responsibilities to its constituent countries, i.e. Wales, Scotland and Northern Ireland (Marsden 2008). The transposition of the

[21] The EAPs are significant policy documents for EI. For example, the Fifth EAP valid from 1993 to 2000 was an important milestone that provided a rationale for "sustainability" and SEA in explicit terms, in Part 1 section 7.3. The Sixth EAP valid from 2002 until 2012 is significant because it encapsulated and reflected the fundamental environmental principles found in European environmental law (Albrecht 2005).

SEA Directive occurred in the UK in such a way that these sovereign states were allowed to make different sets of regulations, as follows (ODPM 2005; POST 2004):

- The Environmental Assessment of Plans and Programmes Regulations 2004 (Statutory Instrument 2004 No.1633);
- The Environmental Assessment of Plans and Programmes Regulations (Northern Ireland) 2004 (Statutory Rule 2004 No. 280);
- The Environmental Assessment of Plans and Programmes (Scotland) Regulations 2004 (Scottish Statutory Instrument 2004 No. 258), and;
- The Environmental Assessment of Plans and Programmes (Wales) Regulations 2004 (Welsh Statutory Instrument 2004 No. 1656 (W.170)).

The SEA Regulations extend to the UK but do not apply to PPs relating exclusively to Northern Ireland, Scotland or Wales, for which the above-mentioned separate territorial provisions apply. The SEA Regulations provided detailed procedures for interpreting, implementing and applying requirements of the SEA Directive (Risse et al. 2003; Schmidt et al. 2005; Fischer 2006). In particular, Scotland has SEA legislation that covers not just plans and programmes, but also policies (Environmental Assessment Scotland Act 2005). This legislation is considered much stronger and more comprehensive than in the rest of the UK, and includes an SEA Gateway run by the Scottish Government and its statutory environmental consultees, which oversees the overall performance of SEA in Scotland (Jackson and Illsley 2007).

Legally, SEA is seen as a supporting tool for sustainable development because in theory, it should ensure that the environment is considered at par with socio-economic aspects (Fischer 2002). While the SEA Regulation provides a legal framework for SEA in the UK, the UK Government planning framework through its planning guidance notes provides the linkages and integration between SEA and planning. The ODPM planning guidance suggests that during PP-making, three assessment processes are carried out together i.e. Sustainability Appraisal (SA), Strategic Environmental Assessment (SEA) and Appropriate Assessment (AA) (ODPM 2005). The SEA Regulations state that when an SA is undertaken, the sections of the SA report that meet the requirements set out for reporting the SEA process must be clearly signposted (ODPM 2005). The legal requirement for an SA is established through the Planning and Compulsory Purchase Act 2004 (hereinafter the Planning Act) (HMSO 2004). SA is “a systematic and iterative process during the preparation of a plan or a strategy which identifies and reports on the extent to which the implementation of the plan or strategy would achieve the environmental, economic and social objectives by which sustainable development can be defined in order that the performance of the strategy and policies is improved" (DETR 2000). In England, the Planning Act makes SA mandatory for Regional Spatial Strategies and Local Development Documents and the ODPM guidance on SA incorporates the requirements of the SEA Directive (HMSO 2004). SEA steps, procedures and expected outputs are circumscribed in legal regulations e.g. the SEA Directive, the UK SEA Regulations and supporting documents such as 'SEA good practice' documents and manuals.

Generally, the policy environment in the UK for SEA-like appraisals and EI has been favorable (Niestroy 2005; Lenshow 2002; Gouldson and Roberts 2000). The UK policies guiding and informing SEA are found in several national and regional documents containing definitions, strategic aims and objectives of environmental protection and sustainable development e.g. (ODPM 2005). These key policy documents are available at the publications portal of the UK government's Department for Environment, Food and Rural Affairs (Defra) website at (http://www.defra.gov.uk/sustainable/government/publications/index.htm). Examples of these documents are:

- *Securing the Future - Delivering a UK Sustainable Development Strategy,* providing strategy for action to deliver sustainable development and ensuring a better quality of life for everyone.
- *One Future - Different Paths,* providing a UK framework for sustainable development to 2020. This has also been agreed by the administrations in Scotland, Wales and Northern Ireland.
- *Choosing Our Future: Scotland's Sustainable Development Strategy,* published December 2005, setting out a vision and commitment to build a more sustainable Scotland.

Several policy documents on EI strategies, priorities, goals and targets and how to integrate the environment into planning documents, exist. For example, national planning policies are set out in new-style22 Planning Policy Statements (PPS) since 2004, gradually replacing old-style Planning Policy Guidance notes (PP). Key relevant EI policy documents include:

- Circulars
- Planning Policy Guidance & Statements (PP/PPS)
- Regional Planning Guidance & Regional Spatial Strategy (RP/RSS)
- Minerals Policy & Guidance (MP/MPS)
- Marine Minerals Guidance (MMG)
- PPS1 Sustainable Development and Climate Change
- PP2 Green Belts

The UK Planning Policy Statements (PPS) provide guidances to planning authorities on how to plan, and at the same time, integrate environmental and sustainability concerns (Marsden 2008). For example PPS1 sets out the Government's overarching planning policies on the delivery of sustainable development through the planning system. It sets out how planning, in providing for new homes, jobs and infrastructure needed by communities, should help shape places with lower carbon emissions and be resilient to the climate change now accepted as inevitable (Stern 2007). The preferred system for integrating environmental concerns has been through the tool of environmental appraisal, as is required by the EC Treaty (Marsden 2008). SEA and EI get their policy guidances indicating priorities and directions from the key documents which have been agreed by all of the administrations in the UK, covering topics such as living within environmental limits; ensuring a strong, healthy and just society; achieving a sustainable economy; promoting good governance; and using sound science responsibly (ODPM 2005).

In addition to the SEA Regulations at UK level, there exist several SEA Guidances (DoE 1991, 1993; DETR 2000; ODPM 2003, 2004a), which are formally recognised documents (Sheate et al. 2004). For example, the *Implementation of Directive 2001/42/EC on the Assessment of the Effects of Certain Plans and Programmes on the Environment* (EC 2003). The UK has been a global front-runner for EI policy documents such as *Sustainable Development Strategies* (SDS), being the first country to prepare them after the 1994 Rio

[22] The 'New-style' planning system was introduced by the 2004 Planning and Compulsory Purchasing Act and replaces the previous 'Old style'. The Planning Policy Guidance (PP) of the 'Old Style' are replaced by the Planning Policy Statement (PPS) of the new style (Gazzola 2006)

Convention on Biodiversity (Marsden 2008). The SDS is a key EI policy document, calling for policy-making agenda that requires careful assessment of the full effects of a policy proposal, to include its economic, environmental and social impacts inside and outside the UK. It identifies four shared priorities for immediate action (ODPM 2005):

- Sustainable consumption and production – achieving more with less;
- Climate change and energy – securing a profound change in energy generation and use, preparing for climate change and setting a good example;
- Natural resource protection and environmental enhancement through a better understanding of environmental limits, environmental enhancement and recovery, and a more integrated policy framework;
- Sustainable communities that embody the principles of sustainable development at the local level.

At the UK level, SEA and EI have traditionally been done through a "policy based approach" relying on a wide range of policy and strategy instruments (Fischer 2005; Dalal-Clayton and Sadler 2005). This has changed as the UK began to adopt more formal and legally binding approaches e.g. SEA and planning regulations (Marsden 2008). The UK SEA policy framework recognises EU-wide agenda found in key documents such as The EU Greening Government, Sustainable Development Strategies, the Lisbon Treaty of Economic and Social Reform (Dalal-Clayton and Sadler 2005; Ross 2000). Other key EU policy documents for achieving EI were the EC Development Policy of 2000 (CEC 2000); the Strategy on Integrating the Environment into EC Economic and Development Co-operation (CEC 2001); and the European Consensus, which explicitly acknowledged the link between development, poverty reduction and environmental issues (EU 2005).

3.3.3 SEA process in the UK

The obligation to ensure that an SEA is done lies with the Responsible Authority, which produces the PP (ODPM 2005). The SEA study may be done either by the authority's own staff or consultants, or a combination of the two. No dedicated body exists to oversee SEAs and the quality management is often integrated in the overall arrangements for oversight of PP formulations. To administer the SEA process, formal and legally binding manuals or guidances exist e.g. *Handbook on SEA for Cohesion Policy 2007-2013* (GRDP 2006) and *The Strategic Environmental Assessment Directive: Guidance for Planning Authorities* (ODPM

2005). The guidances are not an interpretation of the law and should be read in conjunction with the SEA Directive. Responsible Authorities, in consultation with Consultation Bodies (Box 6), must carry out screening to determine whether SEA is required under the Directive.

Box 6: UK consultation bodies in the various territorial jurisdictions

- England: Natural England, English Heritage, and the Environment Agency;
- Northern Ireland: The Department of the Environment's Environment and Heritage Service;
- Scotland (Consultation Authorities): Historic Scotland, Scottish Natural Heritage, and the Scottish Environment Protection Agency;
- Wales: Cadw (Welsh Historic Monuments), Countryside Council for Wales, and the Environment Agency Wales.

Annex II of the SEA Directive lists criteria for determining the likely significance of the environmental effects of PPs and exemptions to the SEA Directive are found under Art. 3(8). The UK SEA type is both objectives-led and baseline-led because it is based on objectives, indicators and targets as well as the environmental baseline (Fischer 2005).

Table 3.1: Linkage and similarities between SEA and SA stages (adapted from Owen and Graham 2005)

SEA/SA stages	SEA Details	SA Details
A	Setting the context, objectives, establishing the baseline and SEA scope.	Setting the context, objectives, the baseline and SA scope.
B	Developing and refining alternatives; and assessing effects.	Developing, refining alternatives; assessing objectives compatibility.
C	Impact assessment, report-drafting	Appraising the effects of the plan.
D	Consulting on draft PP and Environmental Report.	Consulting on draft PP & Sustainability Report.
E	Monitoring significant effects of implementing PP on the environment.	Monitoring implementation of PP on sustainability

The Planning Act requires an SA as well as an SEA to be carried out using a combined methodology, thereby avoiding duplication of effort; allowing for joint procedures with other assessments, and; allowing for sharing of data (ODPM 2005; POST 2005). SEA has many procedural similarities with SA (see Table 3.1); and similarly to SEA, SA adopts an objectives-led approach (Owen and Graham 2005). The content requirements (Annex 1) and format of the SEA report (Annex 2) are formally prescribed by both the SEA Directive and UK SEA regulations, and shall be useful in evaluating SEA reports, as illustrated in the methodology in subsection 2.4.1. Detailed procedures of the UK SEA process are provided in Annex 3.

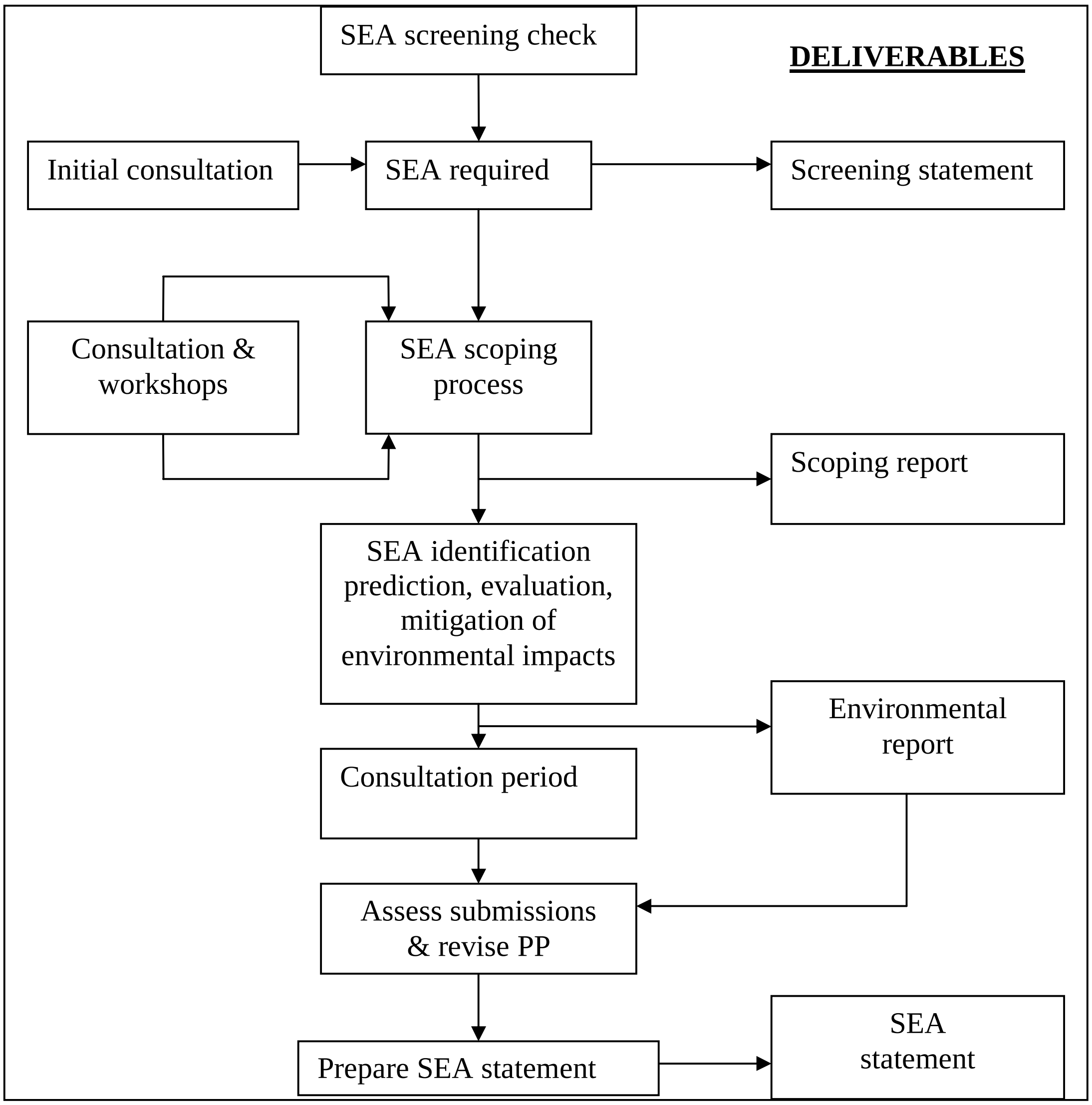


Figure 3.1: An overview of SEA process and outputs (source: COWI and RSP-MCOS 2005).

The parallel implementation of SA and SEA did not hinder the evaluation of EI because the Planning Act states that within the SA report, the requirements for the SEA report, as contained within the SEA Directive, must be clearly flagged and highlighted. Therefore, the resulting EI was well documented and could therefore be evaluated. The SEA stages (see Figure 3.1) are provided by the SEA Regulations and more specific procedures are depicted in Annex 3. Public Participation is required at Scoping and Report review stages, but can also occur at any stage of the SEA process.

3.3.4 Environmental objectives, indicators and targets

By explaining the role of environmental objectives and indicators, this section aims to illustrate their suitability as proxies for quantitatively evaluating EI in PP documents. Environmental objectives and performance indicators are acknowledged mechanisms for EI, although finding truly verifiable objective indicators is almost impossible (Palerm et al. 2007). To protect the environment and promote sustainable development, SEA relies on environmental objectives, targets and indicators (Donnelly et al. 2006; Therivel 2004). While an environmental objective can be the same as an SEA and/or SA objective, an environmental objective is a broad statement of what is intended in order to meet or advance the goals of environmental and sustainable development (ODPM 2005). The UK's SEA guidance (ODPM 2005) distinguishes between three types of objectives:

1) Internal objectives, thus, the objectives of the PP that are subject to an SEA;
2) External objectives, thus, other objectives independent from the SEA process and the PP in question, which may include relevant environmental protection objectives, as well as economic or social ones;
3) SEA specific objectives, which are devised to test the effects of the PP on the environment; compare the effects of alternatives or the extent to which the PP is contributing to the achievement of sustainable development.

Objectives can be expressed in the form of targets, the achievement of which is measurable using indicators. A target is a more specific intended achievement, measuring what can be achieved over a particular timeframe as well as providing a directional or quantitative endpoint (ODPM 2005). An indicator is a variable used to measure progress in achieving an objective or a target, or the performance of a plan against the set objectives (ODPM 2005; Gleave and Cave 2005). Environmental objectives and indicators are not static and are subject to revision. The UK Department of Environment defined indicators as quantified information used to help explain how things are changing over time (DoE 1996). There are various methods that can be used to develop and formulate environmental objectives and indicators.

One of the most commonly used in practice in various disciplines, including policy planning, management and marketing, is the SMART approach (Doran 1981; Scottish Executive 2002). SMART is an acronym that stands for:

- Specific: objectives should specify what they want to achieve;
- Measurable: it should be possible to measure whether the objectives are being met or not;
- Achievable: are the objectives set achievable?
- Realistic: are the objectives set realistically achievable with the resources and capacity available?
- Time: by when should the set objectives be achieved?

Through the SMART approach, it is ensured that the development and formulation of environmental objectives and indicators is comprehensive in their coverage and concise in meaning. Through SMART indicators it is possible to establish a clear link between the PPP formulating process and its outputs, hence facilitating monitoring and evaluation of performance (OECD 2004). Another approach widely used for the definition of environmental indicators is the Driving-Forces-Pressure-State-Impact-Response (DPSIR) framework. As a widely applied indicator framework, DPSIR allows for the identification of dynamic and non-linear relationships between social and ecological systems and a link between driving forces and possible policy responses (OECD 2004). It is particularly used to help map cause-effect relationships underlying environmental problems and to provide a conceptual framework for the description and analysis of environmental problems (Brouwer et al. 2003). In both approaches, formulation of the statements of environmental objectives and indicators are guided by SMART criteria.

Within the context of the SEA Directive, objectives can be derived from public consultation, law, policy, or other PPPs. They can also be identified on the basis of the review of the baseline information and of the environmental problems identified (ODPM 2005). In practice, SEA objectives and indicators are considered a useful way to describe, analyse and compare the environmental effects of a strategic action (Donnelly et al. 2006; Therivel 2004). This then forms the basis for the monitoring and evaluation of a PP’s performance (ODPM 2005; Joachim et al. 1998). Indicators are often chosen according to their relevance to national priorities, objectives and targets and help steer decision-making towards sustainability by offering compass points (Partidario and Clark 2000; Joachim et al. 1998). Overall, indicators are developed to be fully compatible with the overarching objectives of sustainable development. Within the context of the SEA Directive, they are formulated to reflect the following factors (Ecodyn 2006; ODPM 2005):

- Environmental objectives set out in Annex I of the SEA Directive;
- Likely environmental impacts due to the implementation of a proposed PP;
- Environmental objectives stated in other relevant EU, national, regional and local environmental PPPs;
- Potentially significant environmental issues on which there is uncertainty or insufficient data or information;
- The environmental baseline, particularly identified trends, problems and issues;
- Environmental protection objectives stipulated in legislation;
- Suggested objectives from the Consultation Bodies and stakeholders.

Having demonstrated that indicators are an integral part of EI, the quantitative evaluation of statements of environmental indicators shall in this research constitute a relevant component of analysis.

Chapter 4 Quantitative Evaluation in SEA Theory-building

The role of scientific evaluation in the development of SEA theory and practice is indisputable because the results provide an evidence-based framework for grounded conclusions (Pischke and Cashmore 2006; Cashmore 2004; Miller 1993). Scientific evaluation is a crucial requirement for advancing theoretical understanding and practice, and is therefore an important component of a functioning SEA system (Wood 2003; Bonde and Cherp 2000; Lee and George 2000; Curran et al. 1998; Sadler 1996). Touted as the next step in SEA research, performance evaluation is defined as the use of a systematic framework and criteria to evaluate the lessons learnt from SEA practice and the contributions reflected in decision-making processes (Sadler 2005). Such research on performance evaluations has to ensure that it is conceptually justified, methodologically sound, practically viable and tailored to the local context (Retief 2007). It has been suggested that periodic and systematic performance evaluations are required in order to enhance the understanding of why and how well SEA functions, hence facilitating SEA theory-building (Partidario and Arts 2005; Lawrence 1997; Sadler 1996).

Given that the practice of SEA is varied and still developing, it is suggested that periodic evaluations will be able to ascertain that SEA meets its full potential and fulfils its objectives (Palframan 2006; DETR 1998). Furthermore, claims and hypotheses made within SEA can be buttressed within normative and empirically grounded science, as depicted in Figure 4.1 showing how descriptive theory transitions into a normative one. The figure shows how qualitative research can generate hypotheses within the descriptive theory stages and how the hypotheses are iteratively tested empirically so that explanatory descriptions are verified. This is done within the normative stages of theory-building, where SEA needs to apply more quantitative research approaches; a task that has to date been relatively weak within SEA as explained in the introductory remarks in Chapter one. The need for systematic evaluation of SEA that facilitates such theory-verification has been widely expressed (Gazzola 2008; Retief 2007; Fischer 2002), and Dalal-Clayton and Sadler (2005 p. 367) emphasized the value of evaluation by stating that:

"to take SEA forward there is need to undertake reviews of SEA effectiveness and performance, using a systematic framework and criteria to evaluate lessons of practical experience…the focus should be on the contribution of SEA to decisions-making, as afar as possible, on the results achieved".

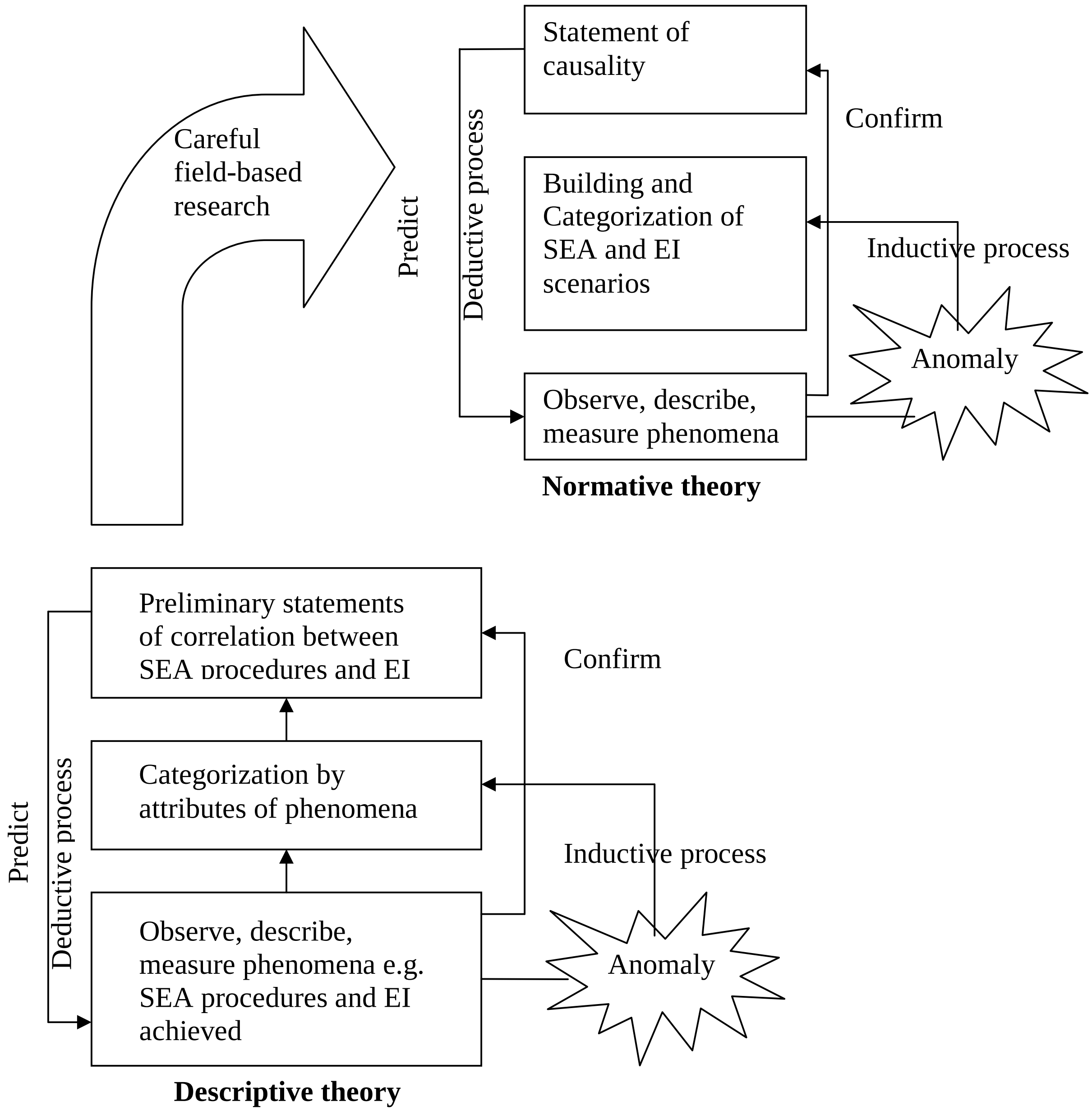


Figure 4.1: Transitioning from descriptive to normative theory (modified from Carlile and Christensen 2005).

Scottish Executive (2002) categorized the purposes of evaluation into three: *Formative*, i.e. feeding information and guidance back into an intervention so that improvements can be made; *Process oriented*, i.e. trying to find out exactly how an intervention works, and; *Outcome oriented*, i.e. focusing on final results of an outcome in order to determine effectiveness or significance of improvement. Thissen (2000) distinguishes between three types of SEA evaluation studies, 1) Evaluating and comparing limited number of studies in depth; 2) Empirical evaluation on large samples of cases; and 3) Across the board 'state of the art' studies. Further, Thissen mentions three levels of evaluation i.e. System-wide, addressing adequacy of regulations, institutions, and knowledge; Specific single SEA processes, and; Specific aspects or components of SEA studies e.g. procedural, compliance, documentation, and methods.

As SEA application expands and its practice increases, it operates within a broad assumption that in any form and at any level, it will help deliver EI. Yet this assumption was not borne out by empirical data because systematic and critical research in this are ahs not been conducted (Runhaar and Driesen 2007; Retief 2007; Fischer 2002; Nitz and Brown 2001). For example, within the context of SEA application on trade related assessments in North America, SEA did not lead to EI in its economic policies (Carpentier 2006). When discussing the efficacy of the SEA process, Carpentier (2006 p. 270) concluded that "…the science remains in its infancy and evidence is sparse". Results of several evaluations have shown that SEA has fallen short of expectations and that the environment has not been sufficiently integrated into PPPs (see Retief 2007; Palframan 2006; Russel 2005; EEB 2005; EEA 2005).

Since the inception of SEA, evaluative research on the quality of SEA processes was initially rare (Doyle and Sadler 1996). Subsequently, general 'Good practice' and/or 'effectiveness principles' have been proposed, prompting researchers to test their validity (IAIA 2002; Verheem and Tonk 2000). Several researchers would latterly apply evaluation criteria in various contexts (see Jones et al. 2005; Noble 2003; Fischer 2002; Hazell and Benevides 2000; Curran et al. 1998). These evaluations concentrated on the effectiveness of SEA procedures and systems. To date, evaluative research focusing on

SEA systematic functions remain rare, while those on substantive aspects are limited in scope (see Cashmore et al. 2004; Fischer 2002). Particular aspects of SEA have also been subjected to evaluations, for example decision-making, scoping, monitoring, public participation and mitigation (see Storey and Noble 2005; Lavallee and Andre 2005; Morrison-Saunders et al. 2003 Fitzpatrick and Sinclair 2003). Despite this recent trend in deconstructing SEA concepts, methodologies and procedures, it must be noted that SEA arose out of practice and was not driven by a purely theoretical agenda (Cashmore 2004; Lee et al. 1995). Therefore such a deconstructive approach may have limitations in adequately depicting the comprehensive role of SEA in achieving EI.

4.1 Qualitative versus quantitative research approaches in SEA

This subsection highlights the shortcomings arising from qualitative research in SEA, and provides potential contribution and benefits of quantitative approaches to SEA research and theory-building. Qualitative research is mainly exploratory. It relies on the collection of data in the form of words, numbers or symbols expressing a value of quality and an indication of trend or direction, rather than a value of measurable quantity (Punch 2005). It requires an interpretive approach to the data collected, whereby the main concern is to make sense of phenomena, in terms of the meanings and values that people (e.g. decision-makers, planners, communities) associate to them (Fontana and Fey 1994).

Several paradigms exist in qualitative research; they set the rhetorical framework in which findings are interpreted and analysed. The most common ones include the positivist and post-modern paradigms (Punch 2005; Neuman 1994). The first emphasises a philosophy, according to which, the only authentic knowledge is the knowledge that is based on actual sense experience. Such knowledge can only come from the affirmation of theories through strict scientific method. Since its formal introduction in the US in 1969, notions of positivism and scientific rationality have dominated environmental assessment. Following this paradigm, it is implicitly assumed that improved decision-making and environmentally sustainable PPPs will result from the inputs of objective evidence, based on observable phenomena, evaluated and quantified through a structured procedure (Bartlett and Kurian 1999). By contrast, the post-positivist or postmodernist paradigm argues that human knowledge is not based on unchallengeable and rock-solid foundations. It is conjectural and can be modified or withdrawn in the light of further investigation.

Within the context of environmental assessment, a shift towards more post-modern approaches occurred based on the need to better appreciate the complexity of policy-making and of environmental assessment, including their dynamic nature, involving a wide range of actors and the influence of new information in decision-making processes (Fischer 2003; Bartlett and Kurian 1999; Miller 1993). Thus, following the post-modern paradigm, it is assumed that environmental assessment should occur in a participatory, open and transparent way, with the aim to build consensus and awareness for the long-term achievement of sustainability goals (Wiklund 2005). Within the context of environmental assessment research, scholars followed the paradigm shift from positivist to postmodernist approaches, in the development of an understanding of what SEA is, of what it should aim to achieve and of how its achievements and performances should be evaluated. This is reflected in the increasing dominance of qualitative approaches to the formulation of SEA research questions and to the framing of problems requiring investigation, involving the use of case studies, matrices, checklists and expert opinions (Retief 2007; Eales et al. 2005; Elling 2000).

Quantitative research is based on positivist or scientific paradigm and leads us to regard the world as made up of observable and measurable facts (Glesne and Peshkin 1992). The term measurement was defined as the assignment of numerals to objects or events according to rules, hence, perceiving measurement as necessarily objective, quantitative and statistically relevant (Stevens 1946). However, some criticisms have been levelled against quantitative methods (Creswell 1994). For example, that numbers are readily manipulated and misrepresented (Duncan 2008); that misinterpretation and misuse of numbers hampers transparency and accountability (Thomas 1998); and that numbers derive from impersonal mathematical rules and therefore are remote and eliminate the exercise of judgement (Porter 1995). Within SEA, quantitative approaches were criticised based on the argument that they failed to capture the nuances and the subjectivity of human knowledge, often expressed in terms of values, perceptions and beliefs (Therivel 2002). Key strengths and weaknesses of qualitative and quantitative research approaches are presented in Box 7.

Box 7: Summarised strengths and weakness of qualitative and quantitative methods		
	Strengths	**Weaknesses**
Qualitative methods	Effective in identifying complex and contradictory effects; Effective in exploring phenomena that is new and unexplored; Can produce patterns and suggest new hypotheses or explanations.	Weak in hypotheses testing, demonstrating correlation and causal relationships; Not easy to guard against subjectivity; Cannot handle large and complex data sets; Weak in making generalizations from single cases to larger samples.
Quantitative methods	Robust in demonstrating correlation and causal relationships; Reliable in hypotheses testing; Allows testing and elimination of competing alternative explanations or causes; Effective in handling large volumes of data, effective in bringing out results of assessments, and generalizations from smaller to larger samples; Allows for more objective measurements.	Weak in dealing with phenomena not reliably measurable in numbers; Can be used to lie or smoothen over contradictions; Poor in identifying contradictions.

Qualitative methods such as case studies are often used in SEA research, representing detailed accounts of SEA procedures, contexts and applications or frameworks (Monnikhof and Edelenbos 2001; Bond 2000; Jones 1999; Glasson et al. 1999; Canter 1996). On the one hand, they generate a contextually rich understanding of the particularity and complexity of a single case (Miller and Salkind 2002; Stake 1988). On the other, they are generally weak in demonstrating correlation and causal relationships, therefore not empirically sound for hypotheses testing or for eliminating the influence of alternative explanations or causes (Punch 2005). Moreover, case studies are chosen on the basis of pragmatic considerations, following a set of identified criteria appropriate to the research being developed, and not from designed case-study templates more suitable for making generalisations to a larger population not involved (Punch 2005; Hinton 2004). Despite the suggested weaknesses, case studies can be most useful in a number of operations. Following Yin (1994), these include:

- Describing current practice and illustrating new and potentially innovative practices;
- Examining difficulties in implementing new procedures and techniques, and examining existing theory to understand and explain happenings;
- Exploring cases of insufficient knowledge to enable hypotheses building within a given context, where there is lack of theorisation.

In summary, while acknowledging that qualitative researches have a role to play in developing SEA theory-building and practice, the complementary role for quantitative research approaches in theory-building is significant (Punch 2005), and should not be ignored.

4.2 Potential of quantitative evaluation in SEA theory-building

While it is not always an objective for undertaking research, theory verification and/or scientific generalisability of the case study findings is justified because the SEA definitional claims are assumed valid across all sectors. Furthermore, conditions and limitations under which the claims, hypotheses and theories are valid need to be determined (Punch 2005; Firestone 1993; Miller 1993). Quantitative research has been directed more at theory verification while qualitative research has typically been more concerned with theory generation (Punch 2005; Burns 1995). Therefore while qualitative research in SEA focused on description and explaining what was happening, quantitative research can establish whether something is the case (Punch 2005). This explanatory focus, in science, is tied to theory, as illustrated in Fischer (2007). Since definitional claims in SEA are considered theories in this research (section 1.2), it justified applying quantitative research in pursuit of verification, in keeping with normative science practice (Punch 2005; Firestone 1993).

In quantitative research, statistical power is an important part of hypothesis testing, as it describes the ability to detect a specified effect, provided the effect exists (Cohen 1988; Dixon and Massey 1983). Several authors have recognized the need to encourage hypothesis testing and statistically based study designs within environmental assessments (EA) (US EPA 1994; Beanlands and Duinker 1983; Fritz et al. 1980; Gore et al. 1979; Green 1979). Curtis and Epp (1999) lucidly illustrated the potential role of deductive science in EA theory-building and decried the failure to apply deductive science in EA, beyond confirming alternative options as explained in Antcliffe (1999). An example in which quantitative approach has been applied in SEA, to determine causal effect, can be found in Bojö et al (2004). They quasi-quantitatively[29] assessed environmental integration (EI) in 95 Poverty Reduction Strategy Papers (PRSPs), based on 17 variables, following four EI criteria i.e.:

1) Diagnosis of environmental issues
2) Analysis of poverty-environment links
3) Environmentally relevant actions
4) Extent to which participation and consultation allowed environmental concerns to be heard.

The variables were scored with a mark between 0 and 3 depending on the extent to which they met the four criteria. While the assigning of scores to express the perceived degree of EI was not precise, the numerical marks were thought to capture clearly interpreted EI

[29] The approach is considered quasi-quantitative because qualitative and subjective criteria were first derived and later used to generate quantitative data for use in a quantitative method such as correlation analysis.

information. Based on their findings, they drew empirical inferences associating EI and SEA-type procedures in PRSPs.

4.3 SEA evaluation elements

To evaluate SEA performance, a structured and systematic approach with a clearly defined scope and boundaries is essential to provide justified reference points for analysis and interpretation of results (Retief 2007). Performance criteria play an important role in improving the understanding of SEA, particularly in the absence of a clear and unambiguous definition (Fischer and Seaton 2002; Brown and Therivel 2000; Verheem and Tonk 2000). To date, several criteria have been proposed to evaluate SEA approaches (see Gazzola 2006; Dalal-Clayton and Sadler 2005; Fischer 2002). These include systems criteria (Von Seht 1999; Elling 1997), reports criteria (Scott et al. 2001; Simpson 2001; Bonde and Cherp 2000; Curran et al. 1998), context and effectiveness criteria (Gazzola 2006) and processes criteria (Noble 2003; Fischer 2002; IAIA 2002). While agreement has been reached on SEA generic principles (IAIA 2002; Fischer 2002; Thissen 2000), no standard evaluation factors or criteria has been agreed upon, although context-specific frameworks are said to be more appropriate than universal ones (Fischer and Gazzola 2006). To guide evaluation in this research, a generic set of SEA key procedural and contextual elements were identified as factors for evaluation. Procedural and contextual elements and their outputs are listed in the SEA Directive (see Annexes 1 and 2) and have also been identified by several authors (e.g. Morrison-Saunders et al. 2007; UNECE/REC 2007; IAIA 2002; Von Seht 1999).

Herein, the term SEA element is used to generally refer to an SEA procedure, its output(s) and SEA context aspects. A procedural element refers to the established generic procedures found in SEA literature, including Screening, Scoping, establishing a Baseline, Impact Assessment, PPP Alternatives identification and evaluation, Decision-making and Review, Reporting, Public Participation and Consultation, and Monitoring and Evaluation (Follow-up) (ODPM 2005; Therivel 2004; Fischer 2002; Sadler 1996). A context element encompasses political, administrative, cultural or planning aspects (see Fischer and Gazzola 2006; Canter 1996). These elements are also found in the several publications on SEA 'Good Practice' principles, procedural and context elements (see for example Therivel 2004; ODPM 2003; IAIA 2002; Fischer 2002; Sadler 2001; Hales 2000; Harrop and Nixon 1999; De Boer and Sadler1996; DoE 1993; Sheate 1992; Lee and Walsh 1992).

Box 8: Indicative list of generic SEA procedural (P) and context (C) elements variously applied in the research's different methods

	SEA element	**Description**
1	Scoping (P)	Determining scale and level of details to be studied in the SEA: setting the Terms of Reference
2	Environmental baseline (P)	Gathering data and information on environmental status, trends, changes, problems; identifying links to other PPPs
3	Impacts assessment (P)	Identifying, predicting and evaluating likely and unlikely potential environmental impacts from proposed PPP
4	PPP alternatives (P)	Identifying PPP alternative that can fulfill intended PPP objectives, including obviating need for the PPP
5	Evaluation of PPP alternatives (P)	Evaluating potential environmental impacts of competing PPP alternatives; identifying the best PPP alternative
6	Mitigation (P)	Identifying measures and plans for adequately avoiding or ameliorating potential adverse impacts
7	Decision-making & review (P)	Presenting final decisions based on clear criteria; accounting for suggestions and comments from stakeholders
8	Report writing	Writing SEA report with easy to read executive summary; and a detailed report covering all the required items
9	Public participation (P)	Consulting statutory bodies, public and stakeholders and soliciting their views during assessments and on draft reports
10	Monitoring and evaluation (P)	Providing measures and plan for monitoring and periodic evaluation of PPP and environmental performance
11	SEA env. objectives (P)	Establishing explicit statements of environmental objectives in the SEA Scope or Terms of Reference
2	SEA framework (C)	Existence of formal SEA requirements and guidance on how an SEA exercise should proceed and what to deliver
13	National/sector env. objectives (C)	Existence of Environmental objectives, targets, benchmarks at national or sector levels
14	Environmental laws (C)	Existence of enforceable environmental laws, rights, responsibilities, liabilities, offences and restitution
15	Public awareness (C)	Existence of public and civic awareness of values, rights, duties, responsibilities towards the environment
16	Quality control (C)	Existence of (independent) body that reviews and approves SEA reports
17	Political will (C)	Existence of Political goodwill supporting application of SEA and acceptance of its results
18	Planning systems (C)	Existence of formal planning system(s) that can be used for integrating SEA and/or achieving EI

The indicative SEA elements (Box 3) used in this research were selected based on the need to cover key generic procedural and contextual SEA elements that are contained within an SEA framework under the EU SEA Directive. From this indicative pool, relevant SEA elements were re-worded to fit the requirements of each method. For example, in the questionnaire survey, eight procedural and eight context elements were used (Annex 6). For the sensitivity analysis, 18 SEA elements deemed to adequately represent the SEA system were used to build the SEA model (Annex 13).

PART III.

RESULTS

"It is a wonderful feeling to recognize the unity of complex phenomena that to direct observation appear to be quite separate things".

Edward O. Wilson (1998 p 5)

Chapter 5 Questionnaire Survey

The findings of the questionnaire survey are organised following the three guiding questions that structured the survey. They represent UK SEA experts' understanding of (1) EI; (2); SEA's role in achieving EI, and; (3) support for the application of quantitative approaches in SEA and EI evaluation. Of the 192 questionnaires sent out, 72 were not delivered by the email service for reasons unknown to the researcher. 63 were delivered but not responded to. 27 respondents stated by email that they did not feel competent to complete the questionnaire. One questionnaire was wrongly completed and 29 were correctly completed and returned. Therefore, the calculated questionnaire response rate was 15.1% and the adjusted response rate was 24.36%. The adjusted response rate is given by first subtracting from the total sample of 192, the number of questionnaires that failed to be delivered (72), were not completed (0), or the returned questionnaires were unusable (1). Then calculating the percentage of 29 from the above sum (i.e. 29 / (192 – 72 - 1) x 100%). This consideration of adjusted response rate enhances the analytical confidence in the survey results. Since no follow-up was done on the non-respondents, response bias i.e. the ability that non-respondents held views different from the study sample (Barclay 2002), was therefore not established.

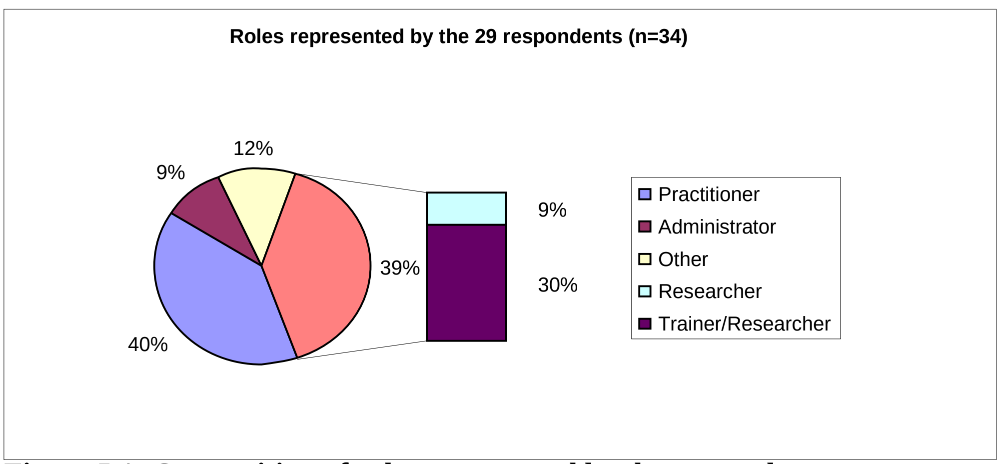


Figure 5.1: Composition of roles represented by the respondents

In terms of areas of occupation of the UK SEA experts 80% of total respondents (Figure 5.1) were a) SEA academics including researchers/trainers; and 2) SEA practitioners. SEA administrators and 'Others'[31], mainly involved with SEA on the peripheries, was least represented. 34 roles were indicated by the 29 respondents because some had two roles e.g.

[31] 'Others', according to the respondents, represented officials who commissioned SEA studies e.g. at international banks and development cooperation agencies.

both SEA researcher and trainer. 75.8% of the respondents were based in England, 17.2% in Scotland, 6.9% in Wales and none in Northern Ireland. The questionnaire ratings of *Very Effective, Effective, Ineffective, Do Not Know* were tested for statistical difference and the results (Annexes 8 and 9) confirmed that they were in most cases significantly different from each other, and hence reliable indicators for analysis. Subsequently, results and findings of specific questionnaire themes are provided in detail in subsections 5.3.1 to 5.3.3, concluded by a summary of the key results in subsection 5.3.4.

5.1 Understanding of EI

Prior to defining EI, the respondents were asked to define the way in which they perceived the term "environment". For all respondents, the term " environment" included the notions of "ecological and biophysical"; and for most, the term included "landscape and built" environment. For half the respondents the environment included "cultural and historical aspects", whilst aspects related with the "social" environment were the least associated with the term (Figure 5.2). Less than 25% of the respondents identified health as an aspect they associated with the environment, although the SEA Directive acknowledges health as a definitive aspect of the term "environment".

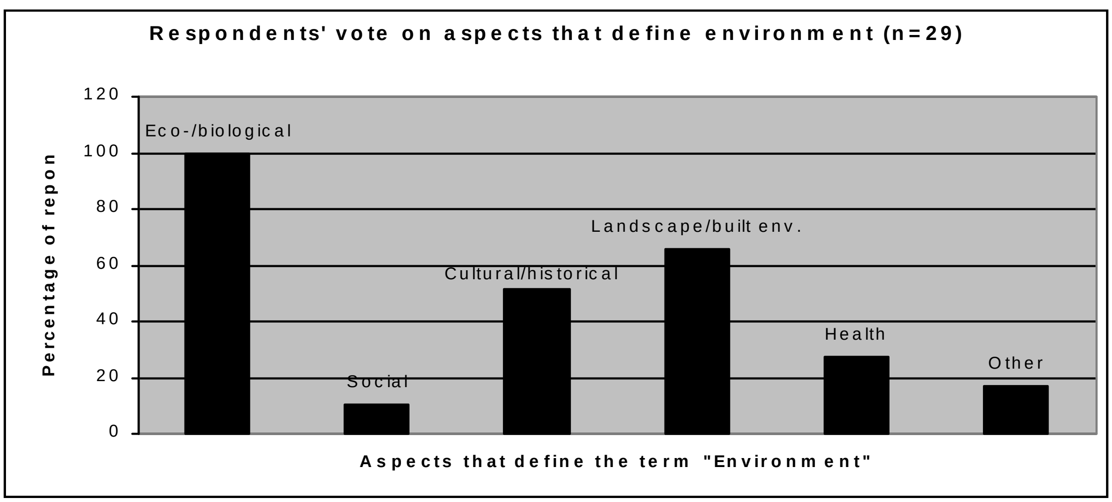


Figure 5.2: Respondents' understanding of the term Environment

Respondents stated that the SEA legislation defines "environment" and makes reference to EI, but does not define EI. It emerged that instead of EI, the expression "Environmental Policy Integration" (EPI) was often used in the UK. EPI involves a continual process to ensure environmental issues are reflected in all policy-making in line with sustainable development needs (http://reports.eea.europa.eu/technical_report_2005_2/en). Whilst, most respondents stated that the expression EI was not defined in the SEA Directive, EI was clearly intended. This interpretation was correct because the SEA Directive preamble, para (4) concretises the relationship between SEA and EI by stating that “Environmental assessment is an important tool for integrating environmental considerations into the preparation and adoption of certain plans and programmes which are likely to have significant effects on the environment in the Member States. When asked what they perceived EI to be, the most popular understandings provided by the respondents were “balancing of environmental, social and economic concerns” and “compliance with legal requirements” (Figure 5.3). The least popular definitions of EI were “solving environmental problems”, and “effective environmental management”. Respondents also added that ‘Other’ understanding of EI existed, i.e. “undertaking impact assessment and integrating those results into PPs”.

From the received open-ended repsonses, it was indicated that as the understanding of the term “environment” has expanded to incorporate aspects of the physical, biological and social environments, the term “sustainability” was often preferred to EI. Some respondents stated that the terms “sustainable development”, “sustainable design”, “sustainable contruction” and “environmental sustainability” superceded the term EI. Other respondents indicated that EI is a European term, adopted mainly by academics but not necessarily by practitioners, who prefer to use “sustainable development” or “sustainability”.

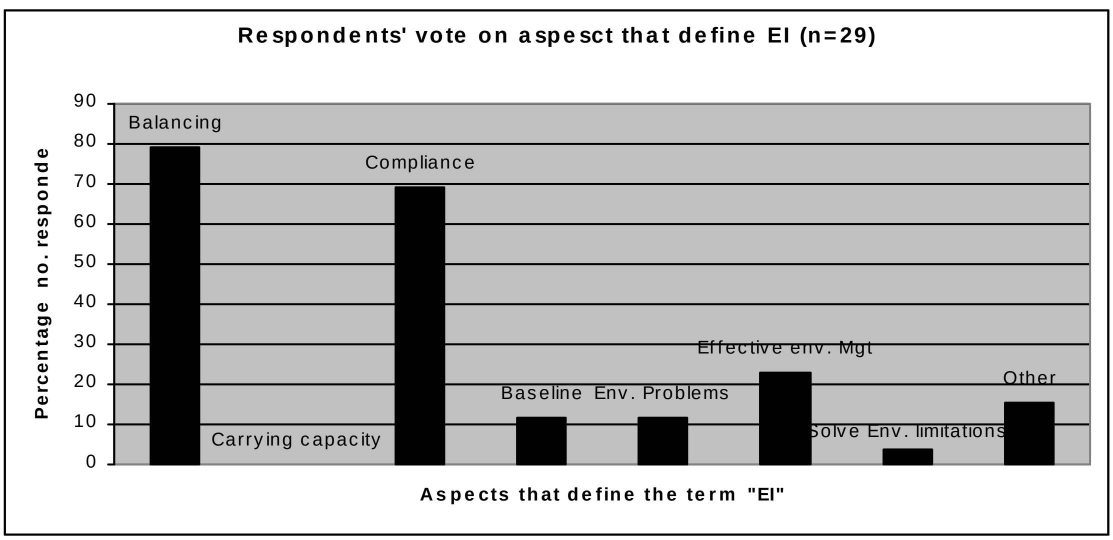


Figure 5.3: Respondents’ understanding of the term Environmental Integration (EI)

From the various understandings of EI inidcated, it is clear that EI is neither a universal nor a homogeneous concept. It conveys different understandings in different sectors. For example, in landuse planning, EI was interpreted as being specifically confined to "balancing environmental aspects with socio-economic aspects". The questionnaire survey results indicated that EI was mainly understood from a procedural perspective, in terms of "balancing" trade-offs between environmental, social and economic concerns and of "complying" with legal requirements. Substantive aspects e.g. "mainstreaming the environment into PP formulation", sustaining the "carrying capacity", and "working within environmental limits", got very few votes in comparison to the procedural notions. This agrees with what is potrayed in the EU and UK SEA frameworks, where the legal framework as well as the SEA definitions are both procedural by nature.

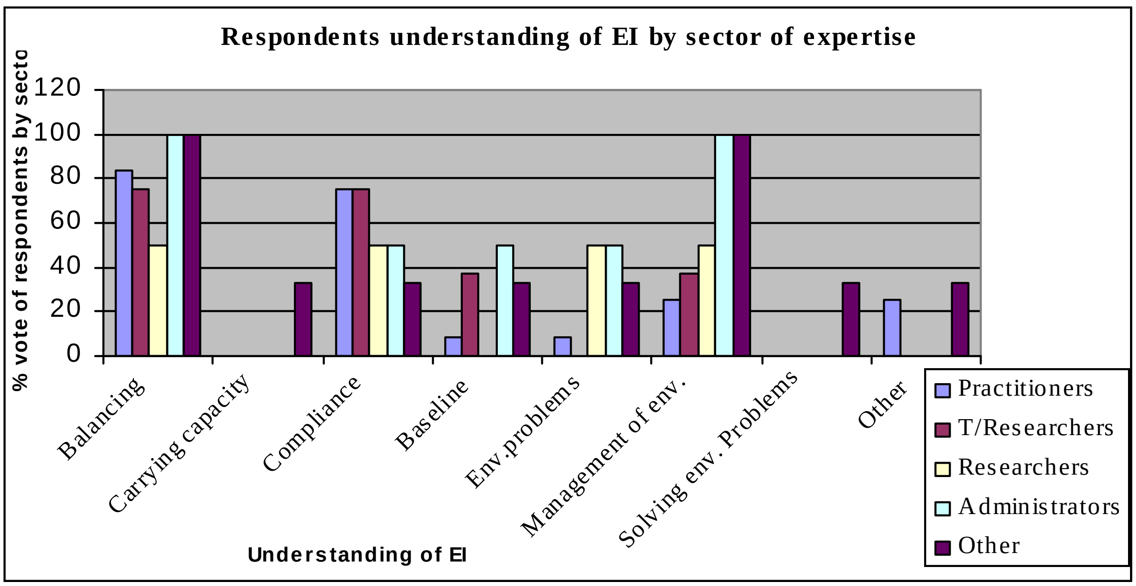


Figure 5.4: Understanding of Environmental Integration (EI) disaggregated by sector of SEA expertise

When the responses were disaggregated according to sectors of expertise, it was evident that differences in understanding of EI exist. For example, while 100% administrators thought EI meant "balancing of environmental, social and economic concerns", only 50% researchers thought so (Figure 5.4).

5.2 Satisfaction with SEA role in achieving Environmental Integration (EI)

Whilst the number of respondents satisfied with SEA effectiveness in achieving EI was almost thrice those dissatisfied, more than half the respondents were ambivalent and indicated they were "neither satisfied nor dissatisfied" (Figure 5.5).

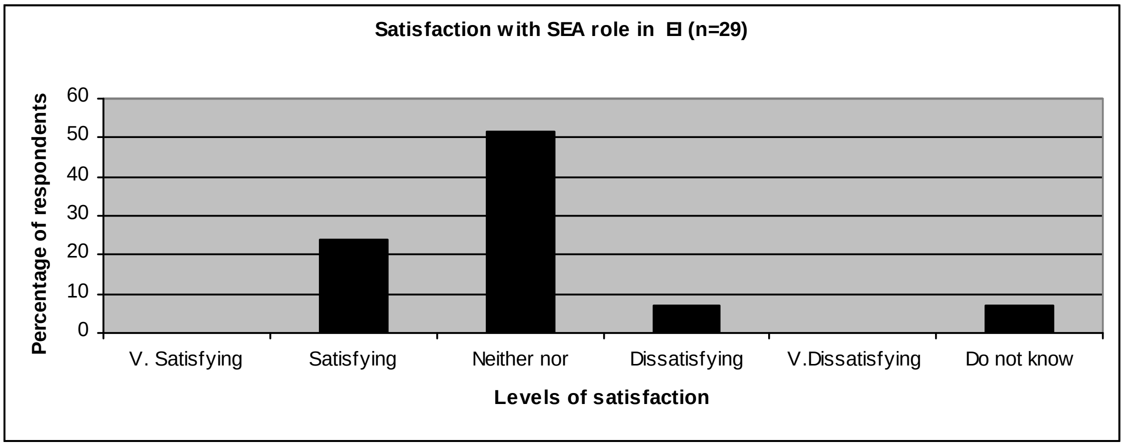


Figure 5.5: Experts' satisfaction with SEA in achieving EI

28% respondents did not believe that SEA achieved EI in PPs for the eight reasons presented in Box 9.

Box 9: Experts' reasons why SEA was not achieving EI in PPPs

1) SEA consultants often merely supplied answers that decision-makers want;
2) Many SEAs have no implementation or evaluation stage to know if environmental considerations were taken into account or followed up;
3) Not all decision-making parties were convinced and supported the potential outcome of the SEA prior to it being undertaken;
4) SEA studies were sometimes donor-driven and the authorities and companies affected were not concerned with the possible outcomes from the SEA report;
5) Institutional and framing issues did not allow the SEA tool to deliver EI;
6) Since SEA findings are only 'taken into account' in decision-making, they are not seen as a constraint and therefore are often outweighed by decisions regarding economic growth and provision of housing;
7) Government puts forward conflicting objectives, e.g. reduce greenhouse gas emissions at national level, but then treble the use of airports. Regional level plans must be in general conformity with national level policy to avoid carrying on these conflicts between various planning levels;

8) Economic issues generally outweigh environmental costs at that level and SEA is often dealt with as a separate process not embedded in normal planning processes.

When the questionnaire results were disaggregated according to the indicated fields of respondents' expertise, it emerged that most practitioners believed that SEA achieved EI; and as well claimed to have encountered proof of it (Table 5.1). All those on SEA periphery i.e. 'Other', believed that SEA delivered EI although only half indicated they had encountered proof. SEA academics were most pessimistic about SEA delivering EI; and few had encountered any proof (Table 5.1). More optimistically, all administrators indicated they had encountered proof: On further analysis, meaning that PPs were "revised to accommodate environmental concerns". From Table 5.1 it was clear that overall SEA experts' opinions on SEA efficacy was divided along lines of expertise or occupation. While those on SEA periphery i.e. 'Other' were most optimistic, SEA academics were most pessimistic; and while practitioners were largely having favourable opinions, administrators who received and reviewed SEA reports held unfavourable opinions on SEA efficacy in delivering EI.

Table 5.1: Disaggregated results on proof and SEA delivery of EI

Question 4. Does SEA bring EI?				
	Yes	**No**	**Total**	**Net vote = (Yes% - No%)**
Practitioner	11 (84.6%)	2 (15.4)	13	69.2%
SEA academics	4 (40%)	6 (60%)	10	- 20%
Administrators	2 (66.7%)	1 (33.3%)	3	33.4%
Other	6 (100%)	0	6	100%
Total	23 (71.9%)	9 (28.1%)	32	43.8%
Question 6. Have you encountered proof that SEA resulted in EI?				
Practitioner	11 (84.6%)	2 (15.4)	13	69.2%
SEA academics	7 (70%)	3 (30%)	10	40%
Administrators	2 (100%)	0	2	100%
Other	3 (50%)	3 (50%)	6	0 %
Total	23 (74.2%)	8 (25.8%)	31	48.4%
Std dev - 3.44; Std. Error – 0.086; Confidence limit (95%) - 1.83				

From Figure 5.6 it was revealed that academics premised their beliefs on statements from experts, as well as on evidence, in comparison to others. Less than one in ten of respondents believing that SEA achieved EI in PPs claimed to have personally encountered “proof and evidence”. Notably, of those who stated that they had encountered proof, 13.8% did not indicate in what form the evidence was, when asked in the questionnaire. This is several magnitudes larger than the standard deviation of 3.44, and therefore implied a significant group not existing by chance. From Figure 5.6 it was revealed that academics premised their beliefs on statements from experts, as well as on evidence. Less than one in ten of respondents believing that SEA achieved EI in PPs claimed to have personally encountered “proof and evidence”. Notably, of those who stated that they had encountered proof, 13.8% did not indicate in what form the evidence was, when asked in the questionnaire. This is several magnitudes larger than the standard deviation of 3.44, and therefore implied a significant group not existing by chance. Further investigation is needed to gather the opinions of such a group.

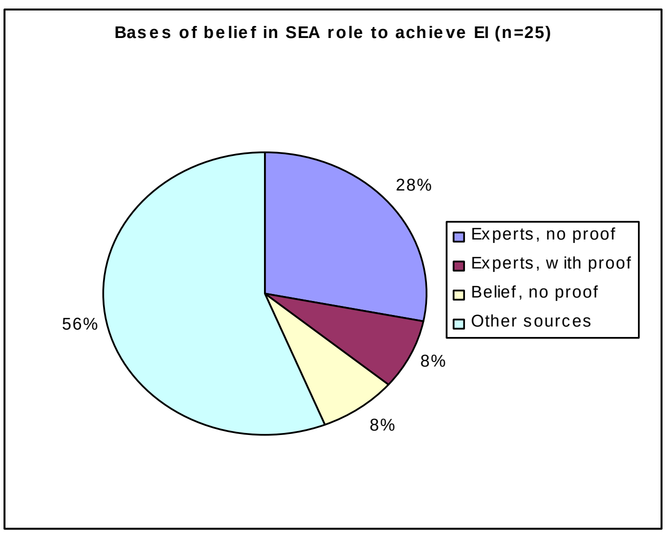


Figure 5.6: Bases of respondents’ belief in SEA ability to achieve EI

More than half the respondents believing that SEA achieved EI largely premised this belief on the statement that PPs were “revised to accommodate environmental concerns”. Of those that had encountered “proof and evidence” 8% indicated that this evidence was in the form of “Statements by SEA experts, but without any proof or empirical evidence”. This implies that about 43% of all respondents had based their opinion on anecdotal evidence. Coupled with the ‘Other’ 56% whose evidence came from “changes in PPs”, then, the picture of low certainty in SEA achievement of EI is further revealed. This is because while it has been stated that SEA demonstrably altered PPs (Fischer 2002), the actual achievement of EI in altered PPs has been reported as modest (Runhaar and Driesen 2007; Therivel and Walsh

2006; Aschemann 2004), questionable (Benson 2003; Mcdonald and Brown 1995) and not satisfactory, as revealed by UK SEA experts' opinions in this subsection.

When asked whether in an SEA exercise it was always clear to identify the SEA elements that were effective in achieving EI, a significant majority were ambivalent (Figure 5.7), exposing either or both inadequate and uncertain knowledge about SEA's causal pathways in delivering EI. SEA elements that resulted in EI were at least clear to nearly one out of every four SEA experts. This low level of clarity is unsurprising since some earlier reports had suggested that there was a need to determine causal pathways in impact assessment, in order to improve efficacy of EAs (Cashmore et al. 2004; Doyle and Sadler 1996).

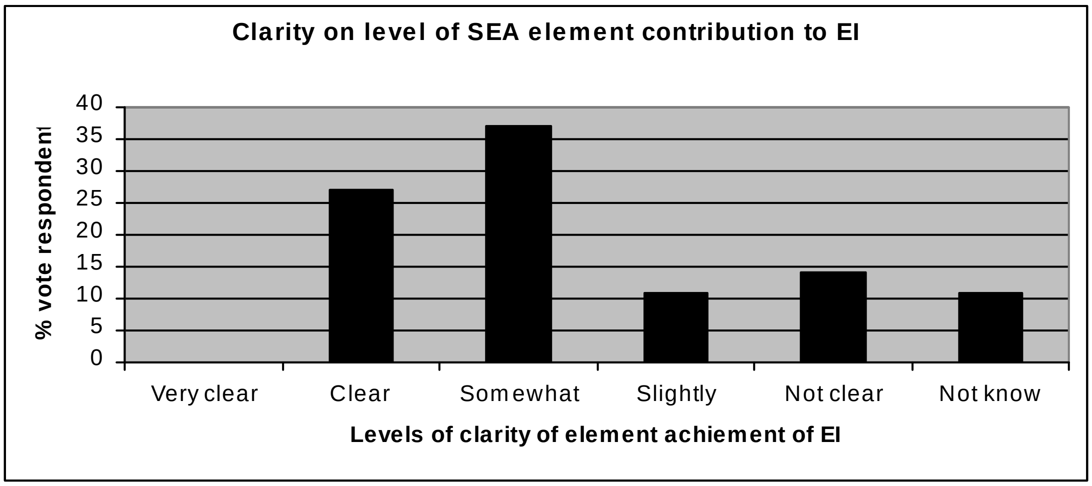


Figure 5.7: Clarity on SEA elements that contributed to achieving EI

It was acknowledged by 2000 that difficulties existed regarding the understanding of SEA's nature and technicalities, aggravated by the diversity of forms in which SEA was practised (Partidario 2006). Such diversity of approaches to SEA critically confused attempts to clearly understand the relationship of SEA with other planning and impact assessment tools, hence clouding the understanding of SEA efficacy (Ibid.). After extensively researching and following the evolution and progression of SEA in Canada, Noble's (2009) recent conclusion that SEA was still not well understood is in agreement with the findings in this research, because the combined votes of somewhat clear, slightly clear, not clear and not know is 71%.

5.3 Effectiveness of SEA procedural and contextual elements

SEA procedures of Scoping and Impact Assessment were indicated to be at least effective in achieving EI, by at least 50% of respondents (Figure 5.8). The procedures where nearly 50% agreed were at least effective were Screening, SEA reporting and Environmental Baseline establishment. The elements most thought of as Not Effective were Public Participation and Monitoring and Evaluation. Six out of eight (75%) procedural elements were indicated as Very Effective by about 10% of the respondents. 5 out of 8 SEA procedural elements (62.5%) were found to at least be Effective in achieving EI by half of the respondents. While the large standard deviation did not give confidence in the data, it can be concluded that there is little to medium confidence in SEA procedures, as there is still a significant number to be convinced in the effectiveness of SEA procedures. This is because the combined votes of Do not Know and Not Effective were at least nearly 50% in 5 out of the 8 procedural elements.

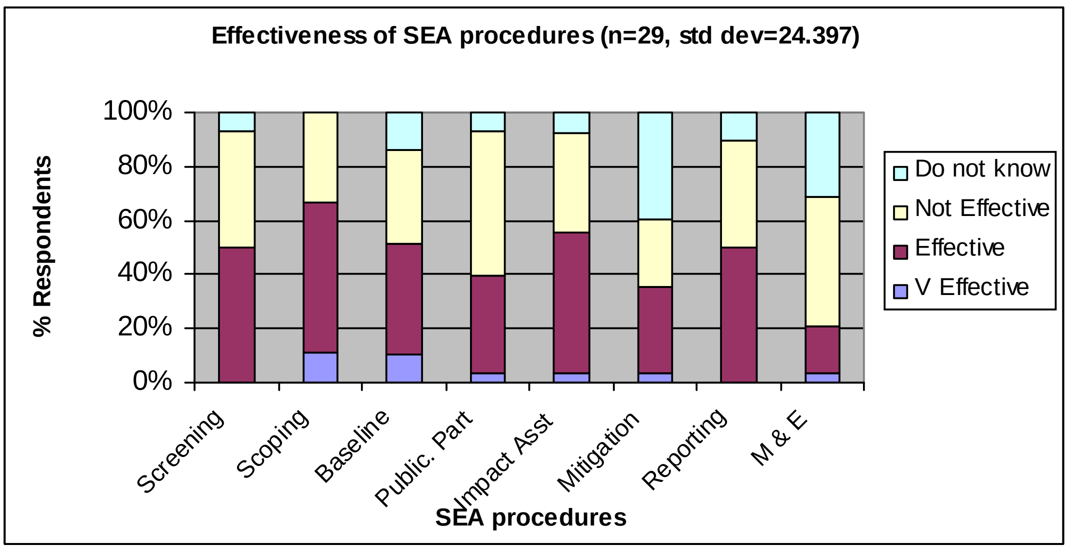


Figure 5.8: Effectiveness of SEA procedural elements in achieving EI

Among the SEA context elements, 5 out of 8 (62.5%) were indicated to be Very Effective in achieving EI, receiving an average vote of 9.45% out of a possible maximum of 10%, per procedure (Figure 5.9). Among procedure elements, 44.4% total votes were cast for at least Effective, compared to 55.55% for Not Effective and Do not Know. A better score was registered among context elements, as 71.6% total votes were for at least Effective versus 28.4% for at least Not effective and Do not Know. These data reveal that respondents thought SEA context elements relatively more effective in achieving EI than procedural. Alternatively, it can be postulated that there are more shortcomings with effectiveness of SEA procedure elements, as compared to context elements, in delivery of EI. This is suggested from Figure 5.10 which provides a combined comparison for both the procedural and context elements. The combined bars for Very Effective and Effective are comparatively larger for context elements than those for procedural; and the combined bars for Not effective and Not Know are similarly larger for procedure than context elements.

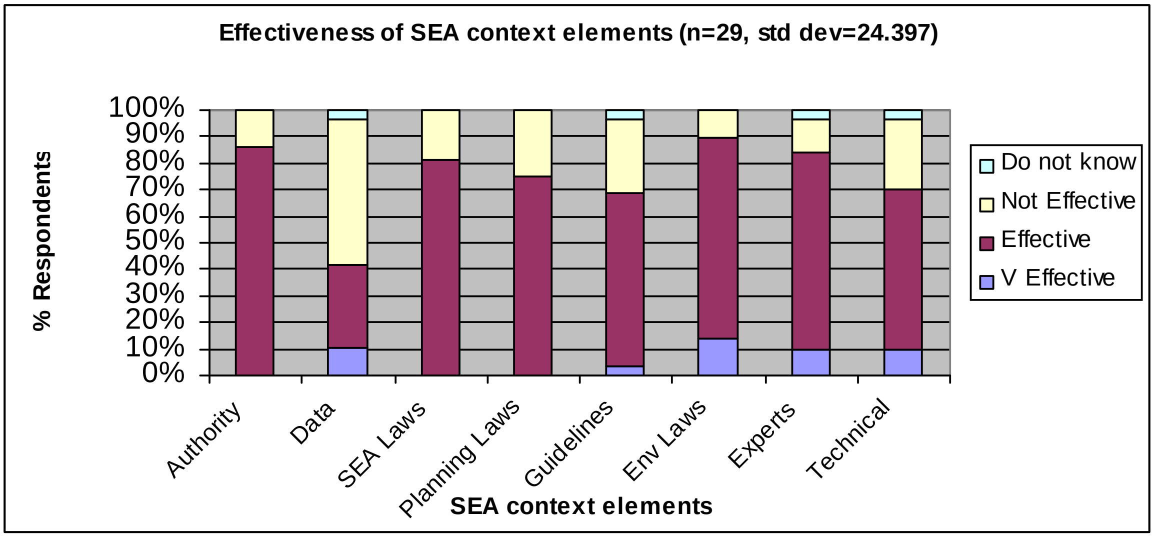


Figure 5.9: Effectiveness of SEA contextual elements in achieving EI

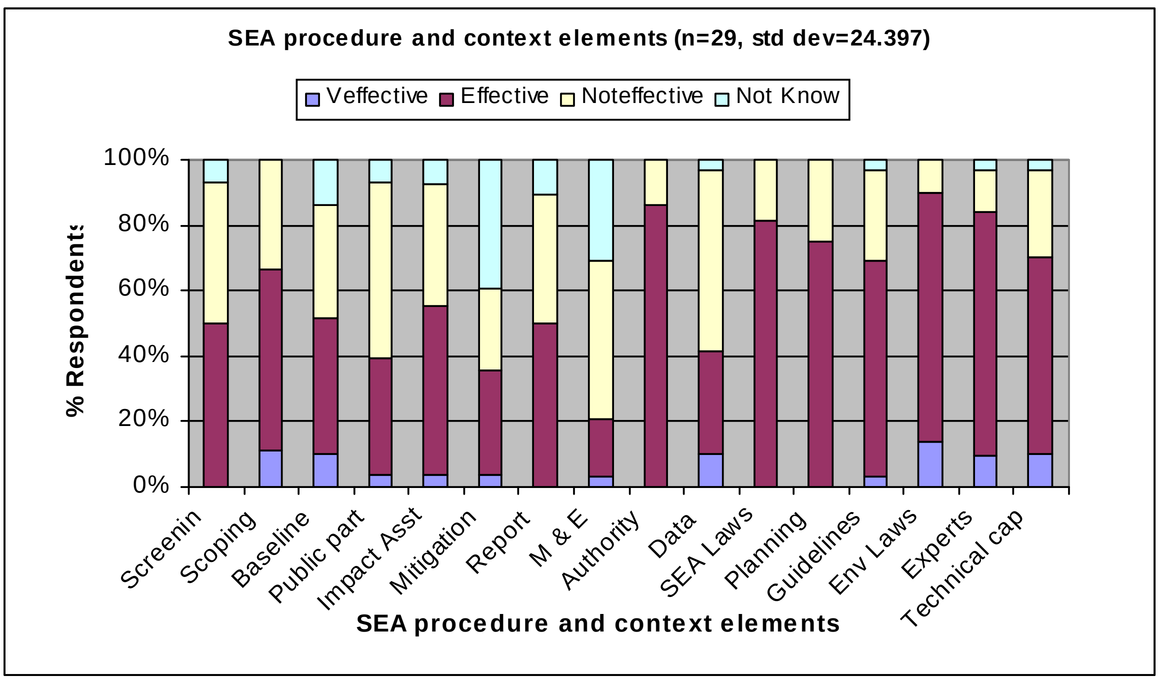


Figure 5.10: Effectiveness of SEA procedural and contextual elements in achieving EI

However, more research is needed to affirm this. Existence of fit for purpose data was the only context element viewed as Not Effective by more than half the respondents. The findings that context elements were perceived as mostly effective in achieving EI concurs with reports in the SEA literature (Fischer and Gazzola 2006; George and Slinn 2003). It is stated that effectiveness in SEA depended on existence of legal systems, environmental legislation, independent review agencies to administer the SEA, and existence of expertise and competence within the SEA practitioners. Since a relatively large proportion of respondents voted in the categories Not Effective and Do Not Know (see Figures 5.7, 5.8 and 5.10), Net Effectiveness, the difference between votes for effective and those against, was calculated and results presented in Figure 5.11.

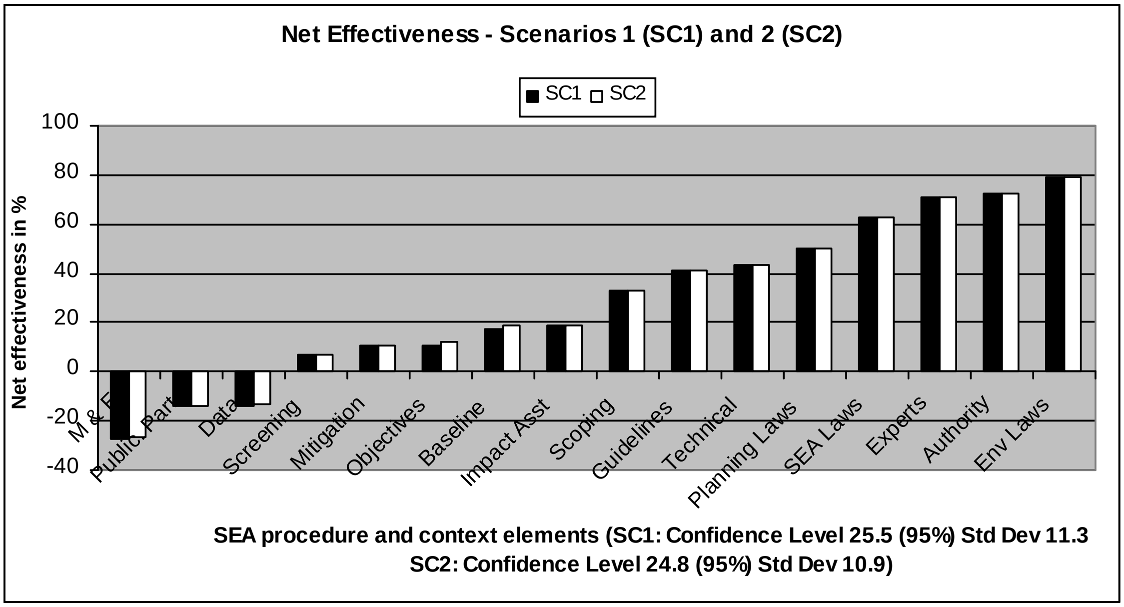


Figure 5.11: Net effectiveness of SEA procedure and context elements

To derive Net Effectiveness score, votes for Very Effective and Effective were added up and then votes for Not Effective subtracted from the sum. To do this, two scenarios were used. In scenario 1, the strict scenario, the Do not Know data was excluded in calculating Net Effectiveness. The votes on Very Effective (VE) and Effective (E) were added up and the votes on Not Effective (NE) subtracted from the sum (SC1 = VE + E – NE). In scenario 2, the Do not Know vote was re-distributed according to voting patterns and proportionally added to the other categories. The votes on Very Effective and Effective were then added up and the votes on Not effective subtracted from the sum. However, both scenarios were almost identical in their results (Figure 5.11). Overall, Net effectiveness was -11.2% in procedural elements, compared to 38% in contextual. This evidence that UK SEA experts think context elements more effective in achieving EI, than procedural elements, is clearly depicted in the graph showing results comparing both procedural and context elements (Figure 5.10). Net Effectiveness in two procedural elements (Monitoring and Evaluation (M&E) and Public Participation (Public. Part)) and one contextual (Data availability (Data)) scored in negative territory. This suggest that more UK experts thought them not being effective, than at least effective, in achieving EI. Net Effectiveness scores were low, scoring below 30%, in half of all SEA elements i.e. Screening, Mitigation, establishing SEA Environmental Objectives, Environmental Baseline establishment, Public Participation, Monitoring and Evaluation, Data availability and Impact Assessment. All except one are procedural elements.

Net Effectiveness scores between 30% and 60% were seen in Scoping, existence of Guidelines for SEA, and existence of Technical capacity and Planning laws. All except Scoping were context elements. Elements receiving significant confidence by scoring above 60% in Net Effectiveness were existence of SEA laws, SEA Experts, existence of SEA Authority (supervisory) and Environmental laws: all are context elements. Context elements enjoyed greater confidence in their Net Effectiveness while procedural elements scored relatively lower on average, per procedure (Figure 5.12). Context elements contributed at least 30% and 60% more votes than procedural elements, to Very Effective and Effective categories, respectively. By contrast, procedural contributed at least 90% and 600% more votes to Not Effective and Do not Know categories, than context elements.

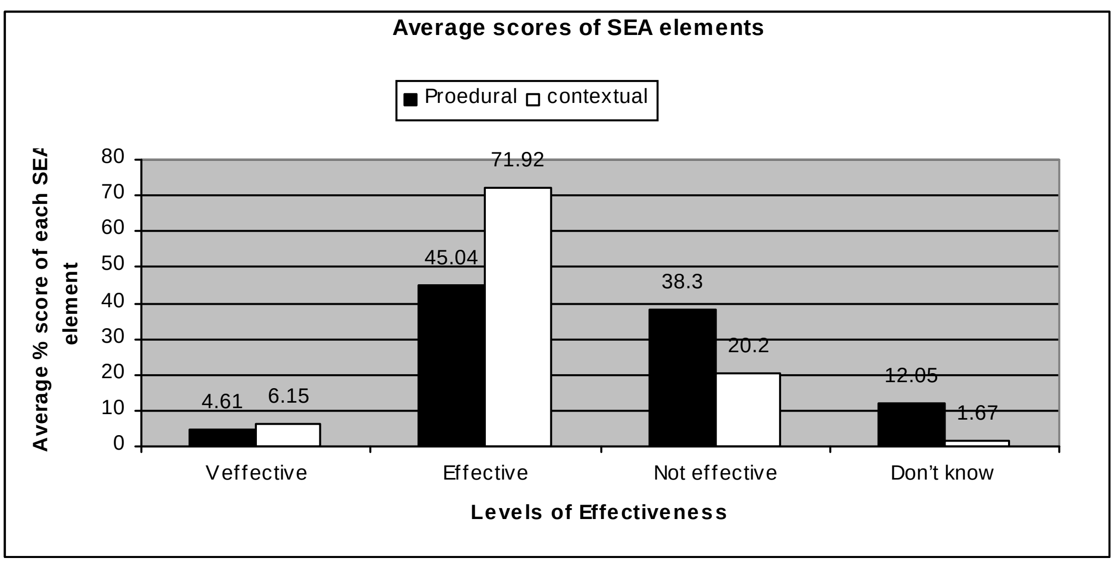


Figure 5.12: Average scores for procedural and contextual elements

The SEA procedural elements contributed 26.7% of the total votes to Net Effectiveness, while contextual elements contributed almost double (57.9%). This means that on average, a contextual element contributed 2.1 times more votes than a procedural element to the overall Net Effectiveness votes. Furthermore, 31.3% of total SEA procedure votes were positive, while almost 96% SEA context votes were positive. This leads to the conclusions that failure in EI was thought to largely emanate from the ineffectiveness of SEA procedural elements rather than contextual.

Whilst the finding of ineffectiveness of procedural elements is corroborated by international literature (see Sinclair et al. 2008; Hanusch and Glasson 2008; Partidario and Arts 2005; Lavallee and Andre 2005), different researchers often come to different lists of factors that contribute to or impede SEA effectiveness (Runhaar and Driesen 2007). For example, in Irish SEA cases, Desmond (2007) found that both procedural and contextual elements hindered the role of SEA in the development of strategic alternatives. Little systematic and critical research has been done in this area (Retief 2007; Nitz and Brown 2001) yet expectations of SEA delivering environmental protection and EI is very high (Dalal-Clayton and Sadler 2004; Zerbe and Dedeuraerdere 2003; Elwell 2002). SEA procedures such as Scoping (Mandelik et al. 2005; Mulvihill 2003; Mulvihill and Baker 2001), Impact Assessment (Wright 2007; Dubé 2003; Piper 2001), Mitigation, Public Participation (Sinclair et al. 2008; Fitzpatrick and Sinclair 2003), Monitoring and Evaluation (Hanusch and Glasson 2008; Partidario and Arts 2005; Lavallee and Andre 2005; Petäjäjärvi 2005) have been stated to be ineffective in various ways and are therefore in need of improvements (Diduck et al. 2007; Noble 2004; Crawley 2003; Sadler 1996).

In agreement with findings in this study, context elements are considered more critical to SEA effectiveness (Gazzola 2006; Fischer 2002; Cherp 2001; Vanderhaegen and Pirotte 2001); for example, the existence of SEA quality review (Noble 2003) and appropriate data (Partidario 2007; Joao 2005b). However, while it is stated in the literature that context elements are essential in SEA success and effectiveness (Gazzola 2008; Fischer and Gazzola 2006), the degree to what the elements, directly or indirectly, systematically determine or contribute to the achievement of EI, is not indicated. Contrary to this study's questionnaire findings indicating that procedural elements were largely ineffective in achieving EI, Deelstra et al. (2003) stated that general ineffectiveness in SEA was related to issues of purpose, rather than practices or procedures. Nevertheless, more authors have recognised the inefficacy of procedural elements, than have of contextual, in delivering EI. Given that international literature largely considers context elements to be critical for successful SEA it can be concluded that the respondents' opinions agreed with international literature. This conclusion holds only to the extent that SEA and EI are quantitatively evaluated within a methodological framework similar to this study's. Such caveat is necessary as some respondents had defined EI as the "altering of PPs by SEA" (see section 5.2) yet this alteration is not necessarily synonymous with EI, and outside the scope of this research. While literature review is replete with suggestions for the improvement of individual SEA elements, almost no literature has looked at the elements within a holistic and dynamic systems-wise context, as understood in this research.

5.4 Quantitative evaluation of SEA and Environmental Integration

While a few SEA respondents (20%) admitted to having quantitatively evaluated an SEA, this largely referred to quantifying the changes that SEA had brought to the plan or planning process. Whilst almost 8% indicated that ALL SEAs should be quantitatively evaluated, more than half the respondents indicated that only SOME SEAs should be quantitatively evaluated (Figure 5.13).

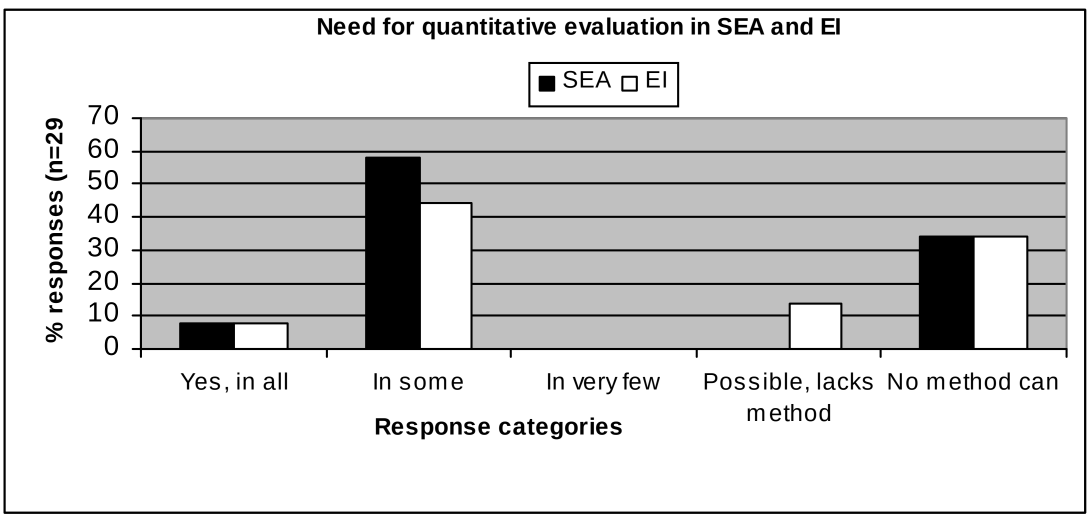


Figure 5.13: Voting patterns on need for quantitative evaluation of SEA and EI

Not a single respondent indicated that a lack of methodology for quantifying SEA existed, although 30.7% indicated that "quantitative evaluations or methods fail to acknowledge the strategic nature of an SEA", agreeing with Therivel (2002). On whether EI in PPs should be quantitatively evaluated, 14% thought that lack of an adequate methodology to capture the nature of EI was a constraint. From the open-ended questions, it emerged that respondents nevertheless saw a role for quantitative evaluation in both SEA and EI, in order to impose vigilance over quality as well as to differentiate SEAs and PPs that do not meet possibly set standards of SEA and EI.

5.5 Summary of results and findings

The following key conclusions can be made from the results and findings of the questionnaire survey:

1) Specific cognition remains weak and clarity poor, of cause and effect pathways between SEA processes and EI. Explanatory knowledge about SEA delivery of EI is poorly developed and not well understood by a majority of SEA experts.
2) Procedural elements were considered relatively less effective than contextual elements, in delivering EI.
3) Among procedural elements, respondents thought Scoping, Impact Assessment and SEA Report writing as most effective in achieving EI; while the least effective were Public Participation and Monitoring and Evaluation.
4) The concepts of Environment and EI were not equally understood by all UK SEA experts.
5) Most respondents understod the term environment to mean two things, 1) ecological and biophysical aspects and 2) landscape and built environment. Aspects associated with the "social" and "health" were the least associated with the term although the SEA Directive includes health in the defination of environmnet ;
6) Opinion towards role of quantitative evaluation of SEA and EI was slightly favourable, tentative and contingent:
    a. slightly favourable because a small percentage advocated for it; and because respondents indicated it could be used to differentiate qualities of SEAs and EI; and because the option of applying quantitative approaches in SEAs was thought possible in some cases;
    b. tentative, because it could apply to some but not all SEAs and EIs;
    c. contingent, based on the indication that while there was need to monitor quality and to calibrate EI, the strategic natures of the EI and SEA processes would correspondingly limit the feasibility. It is notable that those who voted for quantitative evaluation of SEA and EI in ALL cases were academics.

While all respondents considered a method for quantitative evaluation for SEA feasible, about 14% respondents considered one for EI impossible.

7) A point of contention was revealed when no respondent indicated that there was a lack of methodology for quantitatively evaluating SEA; and at the same time, some respondents indicated that it was not possible to capture the strategic nature of SEA.
8) The level of satisfaction with SEA role in achievement of EI in PPPs remains largely low.
9) The basis of knowledge about SEA efficacy was tenuous, with most experts indicating anecdotal evidence as their source of belief in SEA's efficacy, as opposed to empirical evidence.

Chapter 6 Correlation Analysis

The aims of this chapter are twofold: to provide the results[33] and findings[34] arising within the scope of this research. In discussing the results for correlation analysis, the term "significant" shall refer to "statistical significance", and shall describe a difference or relationship that is found important under a two-tailed test of significance at both 95% and 99% confidence levels. Significance is a statistical term that tells how sure one is that a difference or relationship exists. In terms of interpretation, a statistic of significance is taken to mean that the statistic is reliable, without that statistic necessarily corresponding to the element having any practical importance or decision-making utility. Therefore, findings that are statistically significant may not be of any practical utility, or *vice versa*. Furthermore, causality is *per se* not confirmed by results of correlation analysis, and the finding of a significant statistical link is neither proof nor good evidence that there is any real connection between the things linked. However, it is an empirically reliable starting point to identify association usable in verifying claims made within the SEA definitions. Therefore, existence of a statistically significant difference or relationship only tells part of the story, and is itself inconclusive, and other corroborative evidence is needed to affirm what is revealed by the correlation data.

The results of correlation are displayed in table format with names of SEA elements abbreviated for convenience of presentation. The format for abbreviations is that as many letters as can fit the provided box in the table are shown. Written in full, the SEA elements are Scoping, Environmental Baseline establishment, Impact Assessment, Options Identification, Options Evaluation, Mitigation, Consultation, Report writing and Review, and Monitoring and Evaluation. In most correlation results in this study, the Kendall's tau_b correlation data was found to closely follow that of Spearman's rho correlation. Subsequently, the specific results of correlation among SEA elements are presented in subsection 6.1; those among various aspects of EI scores in subsection 6.2 and; the results of correlation between SEA and EI elements in subsection 6.3. The overall key findings are summarised in subsection 6.4. The analysis of results and findings is done in light of existing literature in order to reveal new knowledge and its

[33] A result is the data generated from the application of a method e.g. the results of applying a correlation analysis.

[34] An interpretation of a result, within the research context and in light of other literature review, constitutes a finding.

significance, if any. Results from quantitative evaluation of both SEA procedures and their outputs, and EI, are presented in section 6.5. The results of quantitative evaluation of SEA procedures and their output are presented in subsection 6.5.1; results of quantitative evaluation of EI in subsection 6.5.2; and the key findings and implications are summarised in subsection 6.5.3.

6.1 SEA elements

Following the classification of correlations in terms of low, medium and high (see Table 4.1), SEA aggregated score (i.e. procedure presence tally (TS) + procedure quality (PQ) + procedure output quality (PO)) exhibited medium to high correlations with all SEA procedure quality scores (Table 6.1).

Table 6.1: Spearman's rho correlations – SEA procedure quality scores (PQ) and SEA aggregated score (N = 54)

		Scope	Base	Impact	Option	Mitig	Consult	Report	Monito	SEAagg
SEAscore	Corr	.370*	.516**	.475**	.610**	.472**	.282	.550**	.567**	.956**
	Sig.	.011	.000	.001	.000	.001	.055	.000	.000	.000
Scope	Corr	1.000	.096	.082	.077	.269	-.143	.104	.312*	.272
	Sig.	.	.521	.582	.608	.068	.336	.486	.033	.064
Baseline	Corr	.096	1.000	.145	.081	.085	.235	.236	.450**	.536**
	Sig.	.521	.	.330	.587	.568	.112	.110	.002	.000
Impact	Corr	.082	.145	1.000	.509**	.325*	-.060	.133	.231	.507**
	Sig.	.582	.330	.	.000	.026	.690	.373	.118	.000
Options	Corr	.077	.081	.509**	1.000	.468**	.102	.292*	.143	.637**
	Sig.	.608	.587	.000	.	.001	.495	.047	.336	.000
Mitigation	Corr	.269	.085	.325*	.468**	1.000	.094	-.007	.241	.502**
	Sig.	.068	.568	.026	.001	.	.529	.960	.102	.000
Consult	Corr	-.143	.235	-.060	.102	.094	1.000	.261	.033	.303*
	Sig.	.336	.112	.690	.495	.529	.	.077	.827	.038
Report	Corr	.104	.236	.133	.292*	-.007	.261	1.000	.309*	.484**
	Sig.	.486	.110	.373	.047	.960	.077	.	.034	.001
Monitorin	Corr	.312*	.450**	.231	.143	.241	.033	.309*	1.000	.457**
	Sig.	.033	.002	.118	.336	.102	.827	.034	.	.001

* Correlation is significant at the 0.05 level (2-tailed). ** Correlation is significant at the 0.01 level (2-tailed).

The highest correlation was with Options evaluation procedure quality and Monitoring and Evaluation (M&E), while the lowest correlations were with Consultation and Scoping. The quality of the Scoping procedure was significantly and moderately correlated with that of

Monitoring and Evaluation. It as well registered the highest correlation among the SEA procedures. Mitigation and Reporting writing and Review were the next correlated to Scoping, respectively. Scoping exhibited low and negative correlation with Consultation, though not sign significantly. Scoping was least correlated to Options Evaluation, Impact Assessment and Environmental Baseline establishment, though not significantly. It also emerged that among SEA procedures, Monitoring and Evaluation, Mitigation, Reporting and Options Evaluation procedure qualities had significant correlations with more SEA elements than Scoping. This weak association between Scoping and a majority of SEA procedures was unexpected, because it is commonly acknowledged in SEA literature that Scoping sets the agenda and terms of reference for nearly all SEA procedures (Therivel 2004; Joao 2005); and is therefore understood as a critical SEA quality determinant (Therivel 2004; Mulvihil 2003; Fischer 2002). Scoping was significantly and strongly correlated only to Monitoring and Evaluation, i.e. one out of seven procedures (14.28%); but it had no significant correlation to the other six, implying that it was perhaps not as strongly associated with quality in most SEA procedures. In contrast, Impact Assessment, Options evaluation, Environmental Baseline establishment and Monitoring and Evaluation registered stronger correlations than Scoping.

While it is stated that consultation of authorities and the public can enhance SEA effectiveness (see Therivel 2004; Petts 2003), the results of the correlation survey did not support this. No evidence was found to support that Consultation procedure had a strong or significant correlation with most SEA procedures or the SEA aggregated score. Whilst Consultation was significantly correlated to the procedure qualities of Environmental Baseline establishment and Reporting, it was not to Scoping and other SEA elements.

Table 6.2: Correlation between procedure quality (PQ) and procedure output (PO) (N=8)

		PQ	**PO**
Kendall's tau_b	Correlation Coefficient	1.000	.714(*)
	Sig. (2-tailed)	.	.013
Spearman's rho	Correlation Coefficient	1.000	.881(**)
	Sig. (2-tailed)	.	.004

* Correlation is significant at the 0.05 level (2-tailed). ** Correlation is significant at the 0.01 level (2-tailed).

While it has been stated that Environmental Baseline and Scoping are important to effective SEA (Therivel 2004), this is the first time that the relative correlation between the quality of Environmental Baseline and Scoping procedures to SEA quality has been revealed. SEA procedure quality (PQ) and procedure output quality (PO) were both significantly, highly and strongly correlated (Table 6.2). This implies that generally, the quality of a procedure was a reliable indicator of SEA procedure output quality. The quality of an SEA procedure was found to be a stronger indicator of SEA procedure output quality than the mere presence of the SEA procedure. This is confirmed by the average procedure score (Pavg) being more strongly and almost perfectly correlated to the SEA score, than the average tally score (Tavg) (Table 6.3). This resonated with sentiments that SEA was more about the quality of the process than about the presence of the procedures (Therivel 2004; Brown and Therivel 2000). Nevertheless, the presence of the procedure itself, as indicated by the high correlation scores of the Tallyavg and SEA score, indicates that SEA procedure presence is itself a strong indicator of SEA quality. In several literatures (see Bojo et al. 2004; Fischer 2002), it has been stated that the mere presence of SEA procedures is associated with achievement of EI.

Table 6.3: Spearman's rho Correlations of various SEA scores (N=47)

		Seas core	**Ts SSs**	**TsSs Ospa2**	**TsSsOspa prod**	**Tallavg**	**Pavg**
Seascore	Corr	1.000	.158	.169	.147	.602**	.993**
	Sig.	.	.290	.257	.326	.000	.000
TSsSSs	Corr	.158	1.000	.908**	.990**	.018	.155
	Sig.	.290	.	.000	.000	.906	.298
TsSsOspa2	Corr	.169	.908**	1.000	.931**	.063	.148
	Sig.	.257	.000	.	.000	.675	.321
TsSsOsprd	Corr	.147	.990**	.931**	1.000	.017	.138
	Sig.	.326	.000	.000	.	.911	.357
Tallavg	Corr	.602**	.018	.063	.017	1.000	.573**
	Sig.	.000	.906	.675	.911	.	.000
Pavg	Corr	.993**	.155	.148	.138	.573**	1.000
	Sig.	.000	.298	.321	.357	.000	.

** Correlation is significant at the 0.01 level (2-tailed).

The correlation data was further disaggregated according to sectors[35] (see Table 3.2) and the results are subsequently presented in Tables 6.4 and 6.5.

Development plans

Three SEA elements that registered the most and highest correlations to SEA score at 99% confidence level were Environmental Baseline establishment, Monitoring and Evaluation and Scoping (Table 6.4), in contrast to correlation results from the general sample[36].

Table 6.4: Spearman's Rho Correlations – Development plans (N =23)

		Scopi	**Base**	**Impa**	**Opti**	**Mitig**	**Cons**	**Repo**	**M&E**	**SEA**	**Ospa**	**Ospa 2**	**Sspa5 050**
Scopin	Cor	1.00	.493*	-.064	.160	.453*	.292	.232	.646**	.526**	.314	.370	.394
	Sig.	.	.017	.772	.466	.030	.176	.287	.001	.010	.145	.082	.063
Base	Cor	.493*	1.000	-.174	-.120	.124	.493*	.415*	.690**	.621**	.243	-.048	.009
	Sig.	.017	.	.426	.585	.573	.017	.049	.000	.002	.264	.829	.967
Impa	Cor	-.064	-.174	1.000	.348	-.055	-.180	-.037	-.267	.237	-.010	.125	.072
	Sig.	.772	.426	.	.104	.802	.410	.866	.218	.277	.964	.571	.745
Option	Cor	.160	-.120	.348	1.000	.453*	.189	.097	-.009	.428*	-.246	.004	-.076
	Sig.	.466	.585	.104	.	.030	.387	.660	.966	.042	.257	.986	.730
Mitiga	Cor	.453*	.124	-.055	.453*	1.000	.189	.095	.262	.447*	.072	.328	.289
	Sig.	.030	.573	.802	.030	.	.387	.667	.228	.032	.746	.126	.182
Cons	Cor	.292	.493*	-.180	.189	.189	1.000	.492*	.336	.467*	.104	-.004	.032
	Sig.	.176	.017	.410	.387	.387	.	.017	.117	.025	.636	.985	.884
Report	Cor	.232	.415*	-.037	.097	.095	.492*	1.000	.373	.457*	.010	-.006	.054
	Sig.	.287	.049	.866	.660	.667	.017	.	.079	.029	.965	.979	.806
M&E	Cor	.646**	.690**	-.267	-.009	.262	.336	.373	1.000	.594**	.188	.090	.118
	Sig.	.001	.000	.218	.966	.228	.117	.079	.	.003	.390	.683	.591

* Correlation is significant at the 0.05 level (2-tailed). ** Correlation is significant at the 0.01 level (2-tailed).

In the general sample Scoping was less correlated to most other elements; while in the Development plans, Scoping and Monitoring and Evaluation were significantly correlated to the

[35] Loosely stated, sectors are general fields of SEA application e.g. Development Plans, Transport, Land use, Waste, Energy, Agriculture, Structural Funds

[36] The general sample refers to the disaggregated set of all SEAs used in the research.

highest number of elements. This relatively better correlation of Scoping to other SEA elements, unlike in the overall sample, implied that the correlation results from the Development sector more resembled international literature than the general sample did. Monitoring and Evaluation registered more significant correlations than the other elements. Impact Assessment exhibited negative correlation to all other SEA procedures except Options Evaluation, though not statistically significant. Evidently, the results of Development Plans differed in some aspects with the general sample even though Development Plans constituted about 50% of the whole sample. Impact Assessment is the only procedure quality that did not have a significant correlation with the SEA score, as occurred in the general sample.

Transport Plans

Contrary to results from the general sample and Development Plans, Scoping in Transport Plans was negatively correlated to most SEA variables i.e. Environmental Baseline, Impact Assessment and Monitoring and Evaluation, though not statistically significant (Table 6.5). Generally, SEA score was lowly correlated to SEA elements; and Scoping registered negative but insignificant correlation with 50% of other SEA procedures and 67% of the EI scores.

Table 6.5: Spearman's Rho Correlations – Transport plans (N =10)

		Scope	**Base**	**Impa**	**Opti**	**Repor**	**M&E**	**SEAs**	**Ospa**	**Ospa2**	**Ospa 5050**
Scop	Cor	1.00	-.215	-.166	.197	.000	-.111	.174	-.311	.058	-.058
	Sig.	.	.551	.647	.586	1.00	.760	.631	.382	.873	.873
Base	Cor	-.215	1.00	.385	.102	.069	.645*	.067	.854**	.744*	.812**
	Sig.	.551	.	.272	.780	.850	.044	.853	.002	.014	.004
Impa	Cor	-.166	.385	1.00	.254	.595	.745*	.623	.199	.195	.195
	Sig.	.647	.272	.	.478	.070	.013	.054	.581	.589	.589
Optio	Cor	.197	.102	.254	1.00	.450	.525	.761*	.389	.076	.110
	Sig.	.586	.780	.478	.	.192	.119	.011	.267	.836	.762
Repor	Cor	.000	.069	.595	.450	1.00	.532	.803**	.033	.025	.093
	Sig.	1.00	.850	.070	.192	.	.113	.005	.928	.946	.799
Moni	Cor	-.111	.645*	.745*	.525	.532	1.00	.522	.497	.524	.524
	Sig.	.760	.044	.013	.119	.113	.	.122	.144	.120	.120

* Correlation is significant at the 0.05 level (2-tailed). ** Correlation is significant at the 0.01 level (2-tailed).

6.2 Correlation between EI elements

The quality of environmental statements in terms of SMT criteria (Specific, Measurable, Time-bound) scores for Material assets, Energy, Land use and Climate, respectively, were most correlated to EI scores: with most correlations being strong, high and significant at 99% confidence levels (Table 6.6). OSPA scores moderately correlated to most environmental objectives i.e. in Climate, Land use, Material assets and Energy. In contrast, OSPA2 moderately correlated to fewer environmental themes, i.e. Material assets and Energy. The least correlated to EI (OSPA) was Biodiversity. The best descriptive statistics in measuring EI were observed in OSPA score, followed by OSPA5050, and then OSPA2 (see Tables 6.7 and 6.8). Environmental objectives had significant correlation at 99% level in 8 out of the 9 environmental objectives (OSPA), compared to indicators' (OSPA2) 4. The objectives were strongly correlated to the EI scores that even when the EI score was equally composed of objective and indicator scores (OSPA5050), the correlation effect of the objective score was still more influential than that of indicators. The other EI scores (OSPA6040 to OSPA9010) were generally similar to OSPA5050 score and therefore superfluous. However, this stronger correlation of objectives is misleading in the sense that the evaluation procedure was lenient on the 'T' score in SMT for the environmental objectives, and scored it maximum points as long as a directional or qualitative target was indicated. This was because almost all SEA objectives generally had qualitative and/or directional targets, as opposed to strictly quantitative ones. However, while evaluating the indicators, the 'T' evaluation was stricter and resulted in lower scores for qualitative and directional targets: only quantitative targets got the maximum score.

Table 6.6: Spearman's rho correlation – environmental objective scores (SMT) correlated to EI scores (N=47)

		Biodi	**Water**	**Air**	**Clima**	**Land**	**Cultu**	**Healt**	**Mater**	**Energ**	**Ospa**	**Osp2**	**5050**	**6040**	**7030**	**8020**	**9010**
Biodi	Corr	1.000	.256	-.049	.137	.001	.538**	.268	.126	-.019	.361*	.104	.150	.150	.150	.200	.210
	Sig	.	.082	.743	.359	.994	.000	.069	.399	.900	.013	.486	.313	.313	.315	.178	.157
Water	Corr	.256	1.000	.258	.298*	.135	.402**	.272	.521**	.174	.415**	.233	.305*	.321*	.347*	.319*	.358*
	Sig	.082	.	.080	.042	.364	.005	.064	.000	.241	.004	.114	.037	.028	.017	.029	.013
Air	Corr	-.049	.258	1.000	.472**	-.037	-.233	-.024	.329*	.160	.411**	.121	.248	.275	.303*	.330*	.370*
	Sig	.743	.080	.	.001	.806	.115	.873	.024	.283	.004	.419	.093	.062	.038	.023	.011
Clima	Corr	.137	.298*	.472**	1.00	.252	.096	.152	.361*	.106	.693**	.261	.397**	.424**	.479**	.521**	.594**
	Sig	.359	.042	.001	.	.087	.523	.308	.013	.477	.000	.077	.006	.003	.001	.000	.000
Land	Corr	.001	.135	-.037	.252	1.00	.290*	.089	.418**	.243	.525**	.378**	.431**	.449**	.496**	.508**	.531**
	Sig	.994	.364	.806	.087	.	.048	.553	.003	.100	.000	.009	.003	.002	.000	.000	.000
Cultu	Corr	.538**	.402**	-.233	.096	.290*	1.000	.336*	.520**	.194	.458**	.407**	.431**	.426**	.421**	.437**	.432**
	Sig	.000	.005	.115	.523	.048	.	.021	.000	.191	.001	.004	.002	.003	.003	.002	.002
Health	Corr	.268	.272	-.024	.152	.089	.336*	1.00	.361*	.148	.396**	.297*	.333*	.338*	.334*	.316*	.327*
	Sig	.069	.064	.873	.308	.553	.021	.	.013	.321	.006	.043	.022	.020	.022	.030	.025
Mater	Corr	.126	.521**	.329*	.361*	.418**	.520**	.361*	1.00	.424**	.715**	.489**	.587**	.599**	.624**	.625**	.669**
	Sig	.399	.000	.024	.013	.003	.000	.013	.	.003	.000	.000	.000	.000	.000	.000	.000
Energ	Corr	-.019	.174	.160	.106	.243	.194	.148	.424**	1.000	.488**	.413**	.448**	.445**	.460**	.464**	.474**
	Sig	.900	.241	.283	.477	.100	.191	.321	.003	.	.001	.004	.002	.002	.001	.001	.001

Table 6.7: Spearman's rho correlation – SEA elements (PS) and EI (N=47)

		Scope	Base	Impac	Optio	Mitiga	Cons	Repor	M&E	Ospa	Ospa2	5050	6040	7030	8020	9010
SEAs	Corr	.370*	.516**	.475**	.610**	.472**	.282	.550**	.567**	.200	.022	.042	.042	.031	.066	.098
	Sig	.011	.000	.001	.000	.001	.055	.000	.000	.179	.881	.781	.781	.834	.658	.514
Scope	Corr	1.000	.096	.082	.077	.269	-.143	.104	.312*	.156	.167	.152	.156	.138	.166	.212
	Sig	.	.521	.582	.608	.068	.336	.486	.033	.294	.262	.308	.294	.355	.264	.152
Base	Corr	.096	1.000	.145	.081	.085	.235	.236	.450**	.314*	.092	.131	.138	.138	.151	.174
	Sig	.521	.	.330	.587	.568	.112	.110	.002	.032	.540	.381	.355	.354	.311	.243
Impac	Corr	.082	.145	1.000	.509**	.325*	-.060	.133	.231	.134	.073	.086	.081	.075	.089	.084
	Sig	.582	.330	.	.000	.026	.690	.373	.118	.370	.624	.566	.586	.616	.553	.573
Optio	Corr	.077	.081	.509**	1.000	.468**	.102	.292*	.143	-.001	.049	.017	.001	-.006	.011	-.012
	Sig	.608	.587	.000	.	.001	.495	.047	.336	.996	.745	.910	.995	.966	.942	.939
Miti	Corr	.269	.085	.325*	.468**	1.000	.094	-.007	.241	.011	.047	.048	.048	.033	.043	.034
	Sig	.068	.568	.026	.001	.	.529	.960	.102	.940	.752	.748	.746	.826	.774	.818
Cons	Corr	-.143	.235	-.060	.102	.094	1.000	.261	.033	-.115	-.207	-.201	-.201	-.201	-.180	-.170
	Sig	.336	.112	.690	.495	.529	.	.077	.827	.442	.162	.175	.175	.175	.226	.254
Repor	Corr	.104	.236	.133	.292*	-.007	.261	1.000	.309*	.159	.002	.062	.065	.076	.098	.111
	Sig	.486	.110	.373	.047	.960	.077	.	.034	.285	.987	.680	.662	.612	.513	.456
M&E	Corr	.312*	.450**	.231	.143	.241	.033	.309*	1.000	.266	-.036	.028	.039	.050	.114	.183
	Sig	.033	.002	.118	.336	.102	.827	.034	.	.070	.808	.852	.796	.740	.447	.219

* Correlation is significant at the 0.05 level (2-tailed).   ** Correlation is significant at the 0.01 level (2-tailed).

Table 6.8: Spearman's rho correlation – SEA and EI scores (N=47)

		Sspace	Tspospa	Tspospa2	Sspospa	Sspospa2	TsSsospa	Ospa	Ospa2	Ospaagg	SEAscore	SEAagg
Tspace	Corr	.204	.681**	.377**	.203	.057	.537**	.020	-.028	.000	.157	.181
	Sig.	.169	.000	.009	.172	.705	.000	.895	.852	1.000	.292	.223
Sspace	Corr	1.000	.047	.011	.657**	.264	.364*	-.225	-.074	-.095	.020	.071
	Sig.	.	.753	.941	.000	.073	.012	.129	.620	.527	.893	.637
Tspospa	Corr	.047	1.000	.659**	.578**	.379**	.779**	.648**	.389**	.503**	.155	.158
	Sig.	.753	.	.000	.000	.009	.000	.000	.007	.000	.298	.290
Tspospa2	Corr	.011	.659**	1.000	.381**	.858**	.851**	.492**	.890**	.878**	.129	.158
	Sig.	.941	.000	.	.008	.000	.000	.000	.000	.000	.388	.289
Sspospa	Corr	.657**	.578**	.381**	1.000	.516**	.723**	.469**	.306*	.412**	.023	.060
	Sig.	.000	.000	.008	.	.000	.000	.001	.037	.004	.875	.690
Sspospa2	Corr	.264	.379**	.858**	.516**	1.000	.776**	.373**	.922**	.879**	.054	.099
	Sig.	.073	.009	.000	.000	.	.000	.010	.000	.000	.717	.506
TsSsospa	Corr	.364*	.779**	.851**	.723**	.776**	1.000	.473**	.656**	.696**	.141	.181
	Sig.	.012	.000	.000	.000	.000	.	.001	.000	.000	.346	.224
Ospa	Corr	-.225	.648**	.492**	.469**	.373**	.473**	1.000	.486**	.641**	.200	.142
	Sig.	.129	.000	.000	.001	.010	.001	.	.001	.000	.179	.342
Ospa2	Corr	-.074	.389**	.890**	.306*	.922**	.656**	.486**	1.000	.966**	.022	.043
	Sig.	.620	.007	.000	.037	.000	.000	.001	.	.000	.881	.775
Ospaagg	Corr	-.095	.503**	.878**	.412**	.879**	.696**	.641**	.966**	1.000	.042	.054
	Sig.	.527	.000	.000	.004	.000	.000	.000	.000	.	.781	.717
SEAscore	Corr	.020	.155	.129	.023	.054	.141	.200	.022	.042	1.000	.956**
	Sig.	.893	.298	.388	.875	.717	.346	.179	.881	.781	.	.000

* Correlation is significant at the 0.05 level (2-tailed). ** Correlation is significant at the 0.01 level (2-tailed).

6.3 Correlation between SEA and EI

While there was strong and significant correlation between various SEA scores, the aggregated presence of SEA procedures and quality of procedures and their outputs, there was no significant evidence that these SEA scores were significantly or strongly correlated to any EI score. Apart from the establishment of SEA Environmental Baseline being significantly correlated to OSPA (Tables 6.7), all combinations of SEA scores were found to have very low and insignificant correlations to all EI scores. In Transport Plans, Environmental Baseline establishment highly correlated to OSPA whilst Monitoring and Evaluation moderately and insignificantly correlated to OSPA. In other sectors, SEA procedure scores and SEA scores registered almost no moderate or significant correlation to any EI scores. No identifiable cluster of SEA elements was found to significantly and repeatedly correlate to EI. However, Environmental objective scores for Material assets, Climate and Land use were highly correlated to most EI scores i.e. OSPA, OSPA2, OSPA8020 and OSPA9010 scores (Table 6.8). Furthermore, it was clearly revealed that the correlation got stronger, as the ratio of indicators to objectives increased i.e. from 5050 to 9010, in environmental themes such as Energy, Land use and Climate. This suggests that in these three themes, quality of indicators were consistently done better than objectives. This implies that environmental objectives and indicators are differentially correlated to EI, based on environmental themes. While the indictors were more correlated to EI scores within the Energy, Land use and Climate themes, this was not the case in the rest of environmental themes. For example, environmental objectives were stronger correlated to EI in Material assets, Climate and Land use. This suggests that statements of environmental objectives and indicators are either differentially done or are variously hard to formulate according to themes.

While this study did not reveal significant correlation between SEA procedures and their output and EI, a study by Tojo et al. (2004) found that Poverty Reduction Strategy Papers (PRSPs) that had undergone full SEA procedures scored higher on EI. They also found that variation in EI correlated to specific country contexts. The reasons for high scores were hypothesized in absence of country studies, to be related to "quality of process, and particularly degree to which the environmental constituency was mobilized and allowed to contribute". This gave them credibility to assume that higher level of stakeholder involvement, higher public participation and greater SEA procedures associated with full PRSPs may have improved the scores recorded in full PRSPs. PRSP clusters of low scores in EI were those that had undergone less SEA procedures, leading them to believe that greater

SEA procedures would increase the EI scores. This conclusion from Tojo et al. (2004) is not supported by this dissertation's findings. Instead, it emerged that whilst the presence and quality of SEA procedures were significantly correlated to SEA quality, SEA quality was not significantly correlated to EI. Furthermore, Consultation and Public Participation were not significantly correlated to EI. When results were disaggregated according to sectors, similarly, there was no evidence of any statistically significant correlation between SEA and EI scores.

6.4 Summary of results and findings

From the results and findings of correlation analysis, the following summarised key conclusions are made:

- Presence of SEA procedures, quality of SEA procedures and their output were significantly correlated to SEA quality, but not EI.
- The SEA procedure tally exhibited lower correlation statistics with SEA scores than the procedure quality. This confirms that quality of the SEA procedure is more correlated to the SEA quality, than the mere presence of the procedure; reinforcing the notion that SEA is largely a procedural tool whose value lies in how well the procedures are carried out.
- Absence of correlation between SEA and EI does not exclude that other benefits of SEA did occur; or that forms of EI measurable by other means did occur.
- Commonly touted SEA agenda-setting procedure of Scoping was significantly correlated to fewer SEA procedures than Monitoring and Evaluation, Mitigation and Reporting. This suggests that other SEA procedures are more associated with SEA quality than Scoping.
- Correlation results clearly depicted sectoral differences. The specifics of each sector are reflected in various levels of correlations and in different correlations between elements.
- Some SEA procedures were consistently done better and their outputs were better than others, and three categories were identified. According to this classification, Scoping, Impact assessment and Environmental Baseline establishment were among the best done; while Options evaluation, Monitoring and Evaluation and Reporting among the worst in terms of procedure quality.

6.5 Quantitative evaluation of SEA and EI

The data on quantitative evaluation of both SEA and EI was mostly non-parametric based on results of a test of Kurtosis and Skewness (Tables 6.9).

Table 6.9: Descriptive statistics for average SEA procedure scores (PS) and for various EI scores (N = 47).

	Seasc	**Scope**	**Base**	**Impact**	**Option**	**Mitig**	**Cons**	**Report**
Mean	96.870	99.069	96.427	96.907	95.157	97.361	98.829	95.026
Std Error	0.679	0.366	0.9130	1.223	1.356	0.928	0.554	0.745
Std Dev	4.661	2.509	6.259	8.387	9.301	6.366	3.798	5.110
Kurtosis	20.910	9.897	3.562	21.582	5.499	10.369	12.190	2.115
Skewness	-4.050	-3.039	-2.036	-4.249	-2.402	-3.111	-3.505	-1.540
CL (95%)	1.368	0.736	1.837	2.462	2.730	1.869	1.115	1.500
	M&E	**Ospa**	**Ospa2**	**5050**	**6040**	**7030**	**8020**	**9010**
Mean	96.180	2.475	2.202	2.338	1.182	1.195	1.209	1.222
Std Error	2.248	0.062	0.085	0.066	0.031	0.031	0.030	0.030
Std Dev	15.417	0.427	0.587	0.455	0.219	0.214	0.211	0.211
Variance	237.69	0.183	0.344	0.207	0.048	0.046	0.044	0.044
Kurtosis	34.650	6.864	0.201	2.414	3.417	4.627	5.643	6.450
Skewness	-5.668	-2.608	-0.773	-1.519	-1.783	-2.076	-2.323	-2.514
C L (95%)	4.526	0.125	0.172	0.133	0.0643	0.063	0.062	0.0619

The analyses of descriptive statistics (Figure 6.10) in terms of mean, standard deviation, standard error and confidence interval of the data obtained from quantitative evaluation of SEA and EI revealed that there were no significant errors, and that the data was therefore reliable.

Table 6.10: Descriptive statistics on SEA procedure output quality (PO) (N=54)

	Scope2	Baselin2	Impact2	Option2	Mitiga2	Consul2	Report2	M&E2
Mean	2.9444	2.8344	2.8830	2.7387	2.81	2.9037	2.7682	2.7713
Std Error	0.0191	0.0431	0.0363	0.0677	0.0663	0.0581	0.0568	0.0894
Std Dev	0.1407	0.3171	0.2671	0.4976	0.4874	0.4270	0.4176	0.6574
Kurtosis	11.9186	13.9599	13.3279	16.8655	21.2120	42.1536	37.7035	11.2718
Skewness	-3.2240	-3.2737	-3.2831	-3.5546	-4.1923	-6.2545	-5.7182	-3.3738
CL (95.0%)	0.0384	0.0865	0.0729	0.1358	0.1330	0.1165	0.1139	0.1794

Standard deviation, an indication of precision of the measurements, is a measure of uncertainty and suggests the probability of independent replication of same results (Clegg 2005). The standard error measures the standard deviation of the error in the estimate, and in this study, indicated that the data was reliable. Since the true value of the standard deviation was unknown, the data validity was confirmed by the use of confidence limits and data optimality was confirmed by the 100% inclusion of the data set available. The intervals of the mean at 95% confidence limit fell within the standard deviations in all cases, suggesting that the data was to that extent reliable.

6.5.1 Quantitative evaluation of SEA procedures and their output

Allowing for the standard deviation, corrected by the standard error, the scores for SEA procedures tally (TS) and procedures quality (PS) were classified into three distinct hierarchical categories of similar statistical range values (Table 6.11).

Table 6.11: Ranking according to average scores for SEA procedures tally (TS) and procedures quality (PS). Score rank categories are in parenthesis

Rank	Procedures tally (TS)		Rank	Procedures score (PS)	
1	Scope (1)	0.993519	1	Scope (1)	2.944444
2	Impact (1)	0.988426	2	Consult (1)	2.903704
3	Consult (1)	0.981481	3	Impact (1)	2.883056
4	Baseline (2)	0.964352	4	Base (2)	2.831289
5	Mitigation (2)	0.963889	5	Mitigation (2)	2.81
6	Options (2)	0.96	6	Monitoring (2)	2.771389
7	Report (2)	0.959568	7	Report (2)	2.768209
8	Monitoring (3)	0.938333	8	Options (3)	2.738796
Mean		0.968696	Mean		2.831361
Standard Error		0.006397	Standard Error		0.025809
Standard Deviation		0.018094	Standard Deviation		0.073

This is done by taking the maximum possible score (3) and subtracting from it the sum of standard deviation and standard error. This results in the top TS category containing Scoping, Impact Assessment and Consultation, which statistically have a similar score. The second category consists of Environmental Baseline, Mitigation, Options Evaluation and Reporting, while Monitoring and Evaluation is in the bottom third category. On PS scores, the top ranked category is similar to that of TS while the second category has Environmental Baseline, Mitigation, Monitoring and Evaluation and Reporting, and the last category has only Options Evaluation. Therefore, while category 1 SEA procedures were “most present” and best articulated, Monitoring procedure was the “least present” and worst articulated, in the SEA reports evaluated. While category 1 SEA procedures most conformed to SEA ‘Good Practice’, the Options Evaluation procedure was done to the poorest quality. Based on descriptive statistics the Scoping measurement was most reliable, followed by Consultations, Reporting and SEAscore; Monitoring and Evaluation and Options Evaluation were the least reliable statistically, together with Environmental Baseline and Impact Assessment.

6.5.2 Quantitative evaluation of EI

Several scores for EI were calculated and the descriptive statistics associated with them presented in Table 6.12.

Table 6.12: Descriptive statistics of data from EI scores

	Tallyxpro	**Ospa**	**Ospa2**	**Ospa-agg**	**Ospa6040**
Mean	2.833635	2.47301	2.202738	2.337874	1.182451
Standard Error	0.05732	0.062335	0.085616	0.066383	0.032056
Median	2.9275	2.666667	2.25	2.458333	1.25
Mode	3	2.666667	2.25	2.458333	1.25
Standard Deviation	0.392966	0.427345	0.586953	0.455097	0.219763
CL (95.0%)	0.115379	0.125473	0.172336	0.133622	0.064525
	TSs	**SSs**	**Ospasum**	**Ospaprod**	
Mean	0.460245	0.653776	3.587031	0.782356	
Standard Error	0.033909	0.02748	0.082415	0.083648	
Median	0.4	0.631	3.628148	0.635556	
Mode	0.25	1	#N/A	#N/A	
Standard Deviation	0.232472	0.188392	0.565009	0.57346	
CL (95.0%)	0.068256	0.055314	0.165893	0.168374	

Considering the standard deviation, standard error and confidence interval (Table 6.12), it emerged that OSPA6040, OSPA 7030 and OSPA 8020 and TSs were statistically most reliable while OSPA, OSPA2 and OSPA5050 were relatively least reliable. From the descriptive statistics for the objective (SMT) and indicator (SMRT) scores (Tables 6.13 and 6.14), the best statistics were evaluated using a simple unweighted Multi-Criteria Analysis, and ranked in terms of an average score representing the best mean score; lowest standard error; lowest standard deviation and lowest confidence limit interval. The results from the objectives (SMT scores) and indicators (SMRT scores) are depicted in Table 6.15.

Table 6.13: Descriptive statistics for quantitative data for objectives (SMT scores; N=47)

	Biodiv	**Water**	**Air**	**Clima**	**Land**	**Cultur**	**Health**	**Mater**	**Energ**
Mean	2.5204	2.5027	2.4851	2.3395	2.5448	2.4853	2.5240	2.3927	2.4870
Std Err	0.0825	0.0995	0.0988	0.1186	0.0735	0.0967	0.0816	0.1158	0.0944
Std Dev	0.5656	0.6824	0.6774	0.8131	0.5039	0.6632	0.5596	0.7943	0.6472
Variance	0.3199	0.4657	0.4589	0.6612	0.2539	0.4398	0.3132	0.6309	0.4188
Sum	118.46	117.63	116.8	109.96	119.61	116.81	118.63	112.46	116.89
CL 95%	0.1660	0.2003	0.1989	0.2387	0.1479	0.1947	0.1643	0.2332	0.1900

Table 6.14: Descriptive statistics for quantitative data for indicators (SMRT scores; N=47)

	Biodiv	Water	Air	Clima	Land	Cultur	Health	Mater	Energ
Mean	2.2891	2.1517	2.2825	2.0414	2.3580	2.2421	2.1612	2.1231	2.1761
Std Err	0.1174	0.1451	0.1255	0.1394	0.1171	0.1118	0.1238	0.1395	0.1324
Std Dev	0.8053	0.9951	0.8607	0.9563	0.8034	0.7670	0.8493	0.9564	0.9078
Variance	0.6486	0.9902	0.7408	0.9146	0.6455	0.5883	0.7214	0.9147	0.8242
Sum	107.59	101.13	107.28	95.95	110.83	105.38	101.58	99.79	102.28
CL 95%	0.2364	0.2921	0.2527	0.2807	0.2359	0.2252	0.2493	0.2808	0.2665

Table 6.15: Ranking of objectives and indicators based on relative descriptive statistics (best score ranked 1; worst score ranked 9)

	Factor evaluated	Mean	Std error	Std dev	C L	Av. score	Final rank
Biodiversity	Objectives	2	3	3	3	2.75	3
	Indicators	3	3	3	3	3	3
Water	Objectives	7	9	9	9	7	7
	Indicators	4	7	7	7	6.25	6
Air	Objectives	3	5	5	5	4.5	5
	Indicators	7	6	6	6	6.25	6
Climate	Objectives	9	7	8	7	7.75	8
	Indicators	9	8	9	9	8.75	9
Land Use	Objectives	1	2	2	2	1.75	1
	Indicators	1	1	1	1	1	1
Culture	Objectives	4	1	1	1	1.75	1
	Indicators	6	5	5	5	5.25	5
Health	Objectives	5	4	4	4	4.25	4
	Indicators	2	2	2	2	2	2
Material assets	Objectives	8	8	7	8	7.75	9
	Indicators	8	7	7	8	7.5	8
Energy	Objectives	9	6	6	6	6	6
	Indicators	5	4	4	4	4.25	4

The descriptive statistics for Land Use, Cultural heritage and Biodiversity scores were the most reliable among the environmental themes. This implies that within the OSPA framework, these environmental themes had the best SM(R)T scores for objectives and indicators, compared with the rest. The worst scores were observed in objectives and indicators for Water, Climate and Material assets (Table 6.16).

Table 6.16: Ranking of environmental objectives and indicators (ranks are in parenthesis) based on **scores from Table 6.15**

Rank of objectives (SMT) score	Rank of indicators (SMRT) score
Land Use (1)	Land Use (1)
Cultural (1)	Health (2)
Biodiversity (3)	Biodiversity (3)
Health (4)	Energy (4)

Air (5)	Cultural (5)
Energy (6)	Air (6)
Water (7)	Water (6)
Climate (8)	Material assets (8)
Material assets (9)	Climate (9)

6.5.3 Summary of results and findings

From the results of applying quantitative evaluation to SEA and EI, the following key summarised conclusions are made:

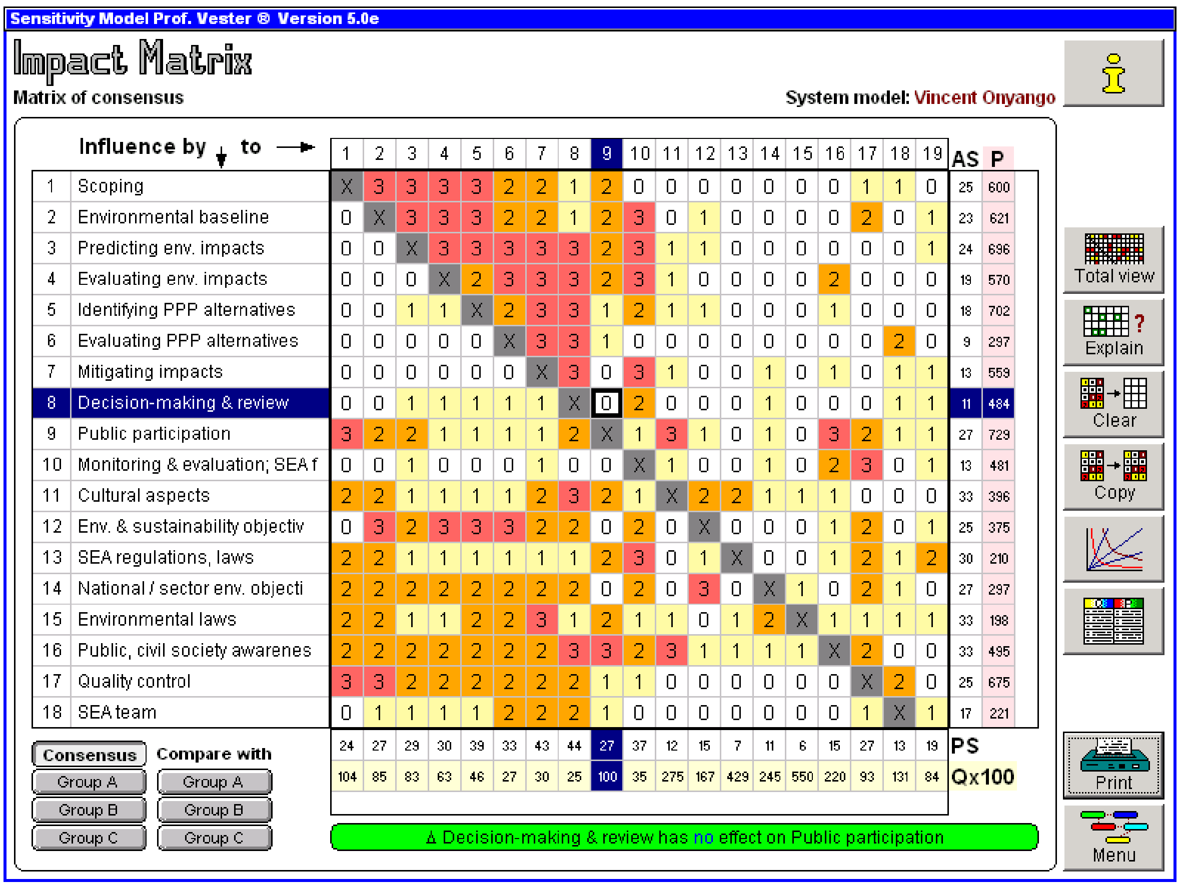
- It was possible to separate the scores for quality of SEA procedures and their output into three distinct hierarchical categories of statistically different classes.
- SEA procedures as well as their outputs are differentially reported in the documents, implying that some procedures are consistently performed differently from others.
- Quality of environmental objectives and indicators were differentially reported according to environmental themes; and both the environmental objectives and indicators tended to be similarly performed in terms of quality, in each SEA report.
- Statements of environmental objectives and indicators were done relatively well in specific themes e.g. Land use, Culture, health and Biodiversity; and relatively worse in Climate and Material Assets themes.

Chapter 7 Sensitivity Analysis

The output of the sensitivity analysis was a cybernetic evaluation and visualization of the SEA process and its various simulations. The results and discussions of the cybernetic evaluation of the SEA process as described by UK SEA experts is presented in section 7.1; and the results and interpretations of the simulated scenarios are presented in section 7.2.

7.1 Cybernetic evaluation

The results of the questionnaire on how SEA elements interact among each other are presented in the impact matrix in Figure 7.1. It shows how strongly a column item reacts when a row item changes; a score of zero being no reaction and three representing strongest reaction.



	Influence by ↓ to →	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	AS	P
1	Scoping	X	3	3	3	3	2	2	1	2	0	0	0	0	0	0	0	1	1	0	25	600
2	Environmental baseline	0	X	3	3	3	2	2	1	2	3	0	1	0	0	0	0	2	0	1	23	621
3	Predicting env. impacts	0	0	X	3	3	3	3	3	2	3	1	1	0	0	0	0	0	0	1	24	696
4	Evaluating env. impacts	0	0	0	X	2	3	3	3	2	3	1	0	0	0	0	2	0	0	0	19	570
5	Identifying PPP alternatives	0	0	1	1	X	2	3	3	1	2	1	1	0	0	0	1	0	0	0	18	702
6	Evaluating PPP alternatives	0	0	0	0	0	X	3	3	1	0	0	0	0	0	0	0	0	2	0	9	297
7	Mitigating impacts	0	0	0	0	0	0	X	3	0	3	1	0	0	1	0	1	0	1	1	13	559
8	Decision-making & review	0	0	1	1	1	1	1	X	0	2	0	0	0	1	0	0	0	1	1	11	484
9	Public participation	3	2	2	1	1	1	1	2	X	1	3	1	0	1	0	3	2	1	1	27	729
10	Monitoring & evaluation; SEA f	0	0	1	0	0	0	1	0	0	X	1	0	0	1	0	2	3	0	1	13	481
11	Cultural aspects	2	2	1	1	1	1	2	3	2	1	X	2	2	1	1	1	0	0	0	33	396
12	Env. & sustainability objectiv	0	3	2	3	3	3	2	2	0	2	0	X	0	0	0	1	2	0	1	25	375
13	SEA regulations, laws	2	2	1	1	1	1	1	1	2	3	0	1	X	0	0	1	2	1	2	30	210
14	National / sector env. objecti	2	2	2	2	2	2	2	2	0	2	0	3	0	X	1	0	2	1	0	27	297
15	Environmental laws	2	2	1	1	2	2	3	1	2	1	1	0	1	2	X	1	1	1	1	33	198
16	Public, civil society awarenes	2	2	2	2	2	2	2	3	3	2	3	1	1	1	1	X	2	0	0	33	495
17	Quality control	3	3	2	2	2	2	2	2	1	1	0	0	0	0	0	0	X	2	0	25	675
18	SEA team	0	1	1	1	1	2	2	2	1	0	0	0	0	0	0	0	1	X	1	17	221
	PS	24	27	29	30	39	33	43	44	27	37	12	15	7	11	6	15	27	13	19		
	Qx100	104	85	83	63	46	27	30	25	100	35	275	167	429	245	550	220	93	131	84		

Figure 7.1: Impact matrix depicting how strongly SEA elements interact

The results of evaluating how the various SEA elements influence each other towards achieving EI are graphically depicted in the *Influence Matrix* (Figure 7.2). The Active Sum (AS) indicates elements that have effect on the system and could be changed if EI has to be affected. The Passive Sum (PS) reveals elements that when changed, would cause a lot of changes to other elements because these other elements rely on it.

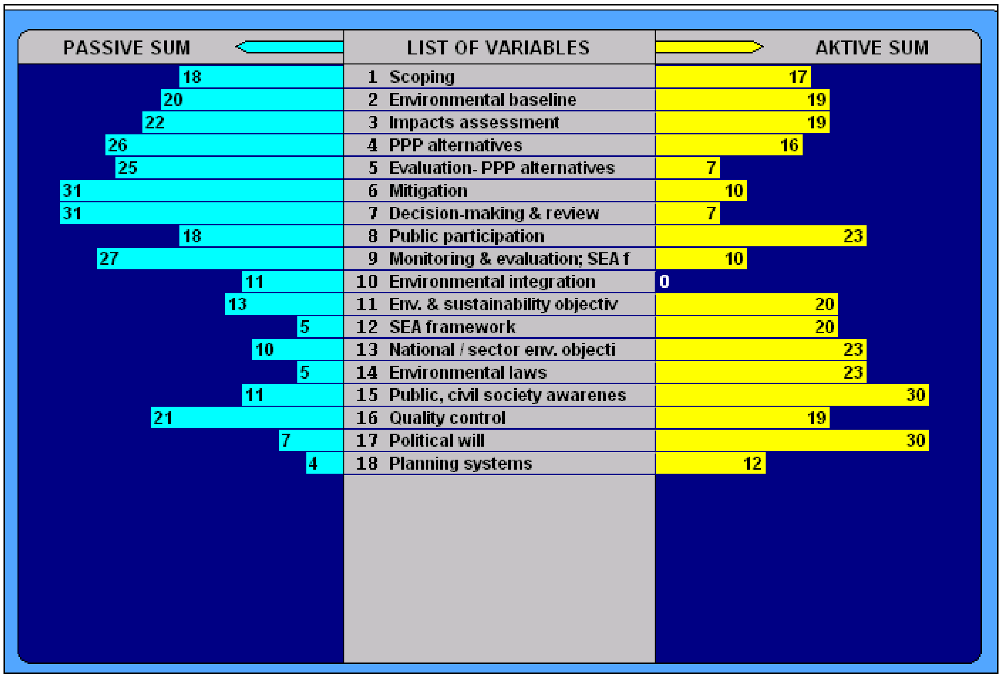
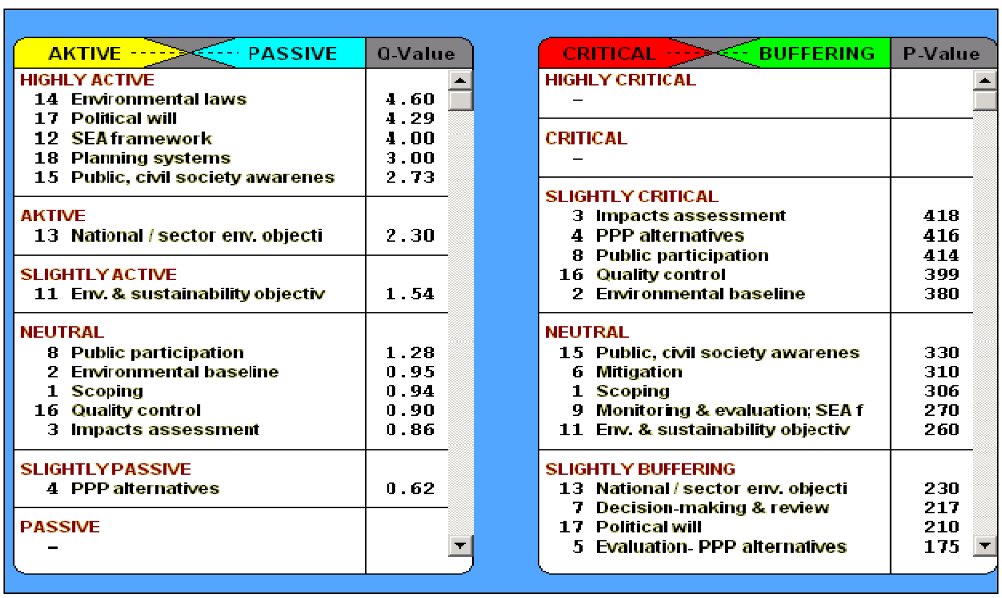


Figure 7.2: Impact values indicating the degrees of influence of each element

From the AS results, Political Will and Public and Civil Society Awareness appear to have most effects, followed by Public Participation, existence of National/Sector environmental objectives, Environmental laws, Environmental/Sustainability objectives and the SEA Framework. The least effects come from Evaluation of PPP alternatives, Decision-making and Review of the SEA report, Mitigation and Monitoring and Evaluation. In international literature, the above elements have variously been suggested for improvements, in order to enhance EI delivery (see Elling 2008; Hanusch and Glasson 2008; Aschemann 2004; Caratti et al. 2004; EEB 2005; Eggenberger and Partidario 2000). Based on the PS results, the elements that when changed will in turn cause changes in a large number of other elements, are Mitigation, Decision-making and Review, Monitoring and Evaluation, Identifying PPP alternatives and Evaluation of the PPP Alternatives. The elements that when changed, will in turn cause least changes in other variables are Planning Systems, SEA Framework and Environmental Laws. Variables scoring high for both PS and AS signify that with every change they not only exert a strong influence on the system as a whole, but also react strongly to changes within it. Whilst they are therefore potential crucial influence factors, great caution is needed when using them. These elements include Scoping, Environmental Baseline, Impacts Assessment, Public Participation, and Quality Control. These variables do not necessarily make good levers because they are also strongly influenced by others.

In this context, high AS scores of Public and Civil Society Awareness and Political Will, matched with relatively lower PS scores, hints that they are better leverage elements. They can be considered as “Background variables”, meaning that they are stronger at influencing others but are much less influenced in return. However, results from the cybernetic evaluation indicated that they are mainly influenced by elements external to the system. This can only be corrected by introducing more feedback loops in order to facilitate internal regulation. In contrast, where both AS and PS values are low, it implies they have little effect in the system, and are themselves coupled with some inertia to changes from within e.g. Planning Systems. To get a more stable system higher AS numbers are needed compared to PS numbers. In Figure 7.2 both AS and PS totals are tied at 305, hinting that in terms of cybernetic systems, this SEA system is stubbornly stable and has the risk of either over-developing or failing to self-correct even when self-correction is desirable. The sensitivity analysis software calculates a k-value deviation that is negative when a system is unstable and positive for a stable system. The system was stable since the k - value deviation is positive (Figure 7.4).

Assessing the Index of Influence



AKTIVE ---- PASSIVE	Q-Value
HIGHLY ACTIVE	
14 Environmental laws	4.60
17 Political will	4.29
12 SEA framework	4.00
18 Planning systems	3.00
15 Public, civil society awarenes	2.73
AKTIVE	
13 National / sector env. objecti	2.30
SLIGHTLY ACTIVE	
11 Env. & sustainability objectiv	1.54
NEUTRAL	
8 Public participation	1.28
2 Environmental baseline	0.95
1 Scoping	0.94
16 Quality control	0.90
3 Impacts assessment	0.86
SLIGHTLY PASSIVE	
4 PPP alternatives	0.62
PASSIVE	
–	

CRITICAL ---- BUFFERING	P-Value
HIGHLY CRITICAL	
–	
CRITICAL	
–	
SLIGHTLY CRITICAL	
3 Impacts assessment	418
4 PPP alternatives	416
8 Public participation	414
16 Quality control	399
2 Environmental baseline	380
NEUTRAL	
15 Public, civil society awarenes	330
6 Mitigation	310
1 Scoping	306
9 Monitoring & evaluation: SEA f	270
11 Env. & sustainability objectiv	260
SLIGHTLY BUFFERING	
13 National / sector env. objecti	230
7 Decision-making & review	217
17 Political will	210
5 Evaluation- PPP alternatives	175

Figure 7.3: Characterisation of influence of individual SEA elements

The P-value (Box 10) reflects how strongly a variable plays a role in the system, i.e. its strength of involvement in system events. A bigger P-value implies a greater and critical role while a smaller P-value implies a lesser role, and buffering character. From figure 7.3 the SEA process did not have any critical variables, supporting the implication that the system is stubbornly stable, and lacking critical elements for effective leverage. It emerges, somewhat against prevailing literature, that for purposes of achieving EI within the UK SEA process, Scoping and Political Will are not critical, although the effect of Political Will in the system is one of the highest (Figure 7.2). Several authors have stated that effective Scoping and supportive Political Will are necessary for SEA to be effective (Elling 2008). While not contradicting existing literature, the results from the cybernetic evaluation, clarifies that while Political Will has significant effect and is a necessary condition for achieving EI, it is not necessarily critical in achieving EI.

Box 10: Derivations of P- and Q-values in Figure 7.3	
Q - value = AS / PS	P - value = AS X PS

The Q-value (Box 10) reflects the active or reactive character of a variable. It tells whether a variable has something to say, or is merely listening, quite regardless of its strength. A higher quotient, with small product, means the variable has something to say even if it is weak to speak. From Figure 7.3 it is revealed that Political Will potentially has the most to say in achieving EI, regardless of whether this potential is actually tapped. In this context, following the low P-value, it is concluded that Political Will's potential towards achieving EI has been little exploited. This corresponds to the oft decried lack of effective supportive political goodwill in accepting the SEA tool and its results (see Elling 2008; Devlin and Yap 2008). Public Participation, Environmental Baseline, Scoping, Quality Control and Impacts Assessment, have the least to say in terms of achieving EI, despite the fact that they may have strength within the system dynamics, to influence EI.

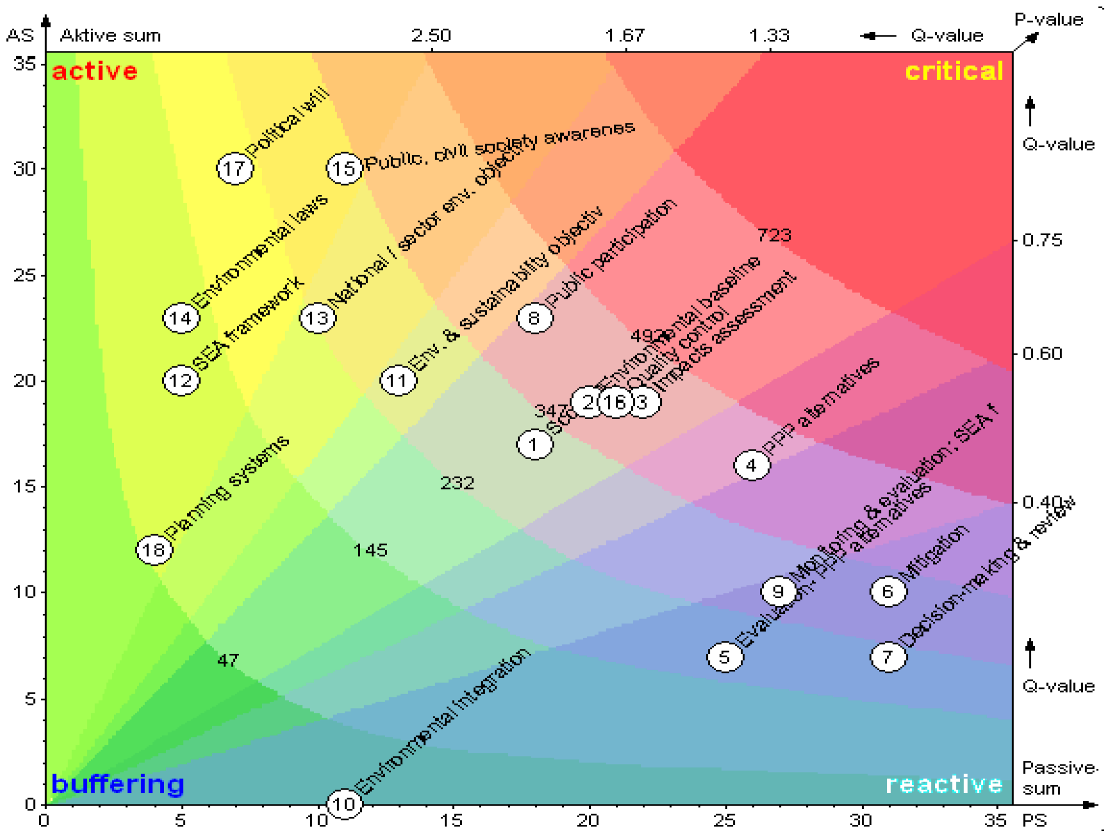


Figure 7.4: Spread of SEA elements according to systemic roles (i.e. active, reactive, critical and buffering). Total number points = 305; K-Value deviation of (n-1)^{2} = 5.5%. (**LEGEND:** 1 - Scoping; 2 – (Describing) Env. Baseline; 3 - Env. Impacts Assessment; 4 – (Identifying) PPP alternatives; 5. - Evaluating PPP alternatives; 6.- Mitigation; 7. - Decision-making & Review; 8.- Public Participation; 9.- Monitoring & Evaluation / SEA follow-up; `10 Env. Integration; 11. - Env. & Sustainability objs; 12.- SEA framework; 13. - National / Sector Env. Objectives; 14.- Environmental Laws; 15- Public and Civil Society Awareness;16- Quality Control; 17- Political Will; 18-Planning Systems)

From the matrix of influence, an evaluation of the effects of SEA elements and their system-wise roles in terms of dominance (active) or susceptibility to influence (reactive), and buffering to critical, was done and results displayed in Figure 7.4. The distribution between these four points representing characteristics (i.e. active, reactive, buffering, critical) shows how intervention in an element can be used to influence the system. Through the influence matrix the cybernetic role of the system can be graphically depicted so that the pattern distribution of variables to the four corners reveals whether the variable is:

- A lever (active)

- A risk factor (critical)
- A measuring sensor (reactive)
- An inert element (buffering)
- Or in any position in between.

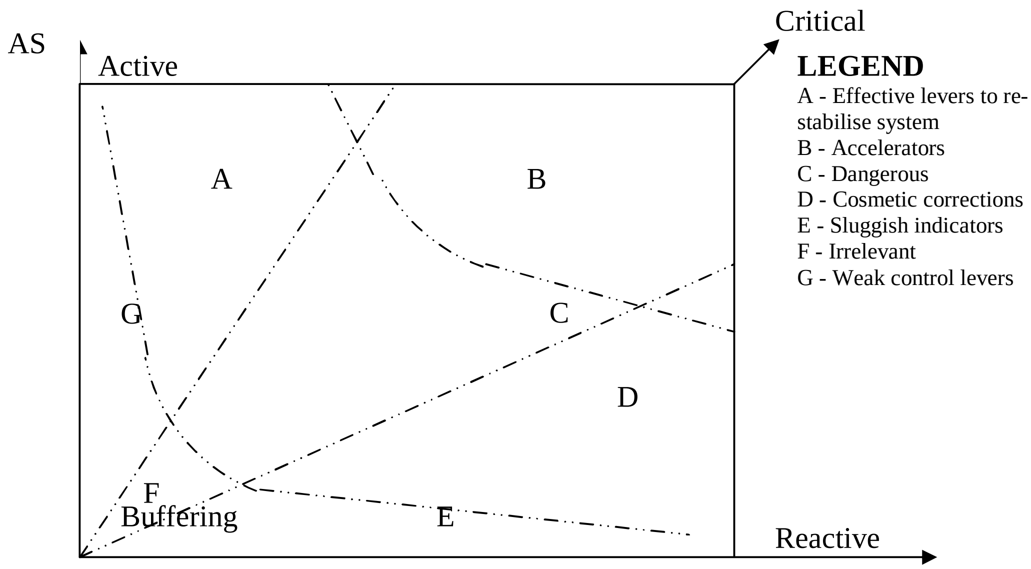


Figure 7.5: Scheme to interpret the graphical spread of SEA elements (source: Vaster 2007)

In Figure 7.4 the radial dividing lines correspond to transitions from highly active to strongly reactive, whilst the hyperbolas transition from buffering to highly critical. The central rectangle containing National/Sector objectives, Scoping, Quality Control, Impact Assessment, Environmental Baseline, and Environmental/Sustainability objectives, correspond to the neutral area. It is difficult to steer the system with these elements lying here. No element lies in the critical zone, while in the reactive zone lay Monitoring and Evaluation, Mitigation, PPP Alternatives Evaluation and Decision-making and Review. In the active zone are Public and Civil Society Awareness and Political Will, reflecting effective control levers that will re-stabilise the system once a change has occurred. Both are context elements. The Planning Systems (or Framework) is a switch lever to be used without reacting itself. It is a background variable that cannot be influenced via the system, but must be influenced from outside. It has emerged that the most active and influential elements are Political Will and Public and Civil Society Awareness, agreeing with Elling (2008) that politics is a determining factor of EI. These elements should be considered as priority for leverage, if one wants to influence the SEA system and its dynamics, towards EI delivery. It is noteworthy that

Scoping, which is touted in literature as critical within the SEA system, is not in this group. Neutral and therefore not having much influence are Public Participation, Environmental Baseline, Scoping, Quality Control, Impact Assessment and PP Alternatives Evaluation. This implies that while tinkering with them might influence the system dynamics, EI will not necessarily be achieved; and that other more important variables should be prioritised as levers. While it has been suggested that the Political Will is critical in determining effective SEA practice (Fischer and Gazzola 2006; Caratti et al.2004; Kornov and Thissen 2000), the sensitivity analysis revealed Political Will not to be a critical element, based on the context of this research. Rather, the Political Will was identified as an effective lever in re-stabilizing the system (Figures 7.4 and 7.5).

Assessing the feedback loops

From the element interactions in figure 7.6 it is clear that SEA is a complex dynamic system exhibiting a high order interaction (Upton and Cook 2002) i.e. an interaction involving more than two variables, to produce EI. The feedback analysis of the effect system allows recognition of dominant cycles and establishment of the relationship between self-control and mutual amplification, to be established. Scoping, Environmental Baseline, Mitigation and Monitoring and Evaluation appear involved in most positive and negative loops (Figure 7.6). Public and Civil Society Awareness and Public Participation are potential targets for influencing the negative loops, while Environmental Baseline, Mitigation and Monitoring and Evaluation are key elements for influencing the system through the positive loops, suggesting a flow system dependent on external factors. Presence of more feedback loops would indicate a more self-regulating type of behaviour. The degree of interconnectedness (degree of networking), a basic cybernetic index evaluated according to the Prof. Vester's 8 bio-cybernetic rules (see Annex 10), gives important indications of systems viability. Elements 6, 8, 9, and 15 appear prominent in negative feedback loops, whilst 2, 9, 11 and 6 in the positive. In the figure a representation of feedback loops such as 1-8-1 means that the negative feedback originates from element 1, goes to element 8 and finally provides a depressant effect on element 1. Based on the concept of Prof Vester's Sensitivity Model (Vester 2007), the closeness in total number of negative and positive feedback loops is an interpretation that the system is dependent on external factors. To remedy this, SEA system will require, preferably, more short loops between variables to allow for swift reaction and more effective interaction.

The greatest payload in EI achievement will come from focusing on changes identified within a systems perspective, recognizing context conditions, and appropriately identifying key systems-relevant levers, within that context. Lee (2006) already urged for most cost-effective leverages to be identified in order to make SEA more effective. One of the suggestions from a study done by Bojö et al. (2004) was that there should be a search for cost-effective synergies between Public Participation measures and environment measures. This implied that instead of significant resources being spent on a particular SEA element in order to improve EI (e.g. Scoping), priority might instead be given to a group of others (e.g. Monitoring and Evaluation and Mitigation), in order for the resultant costs to correspond to greater benefits, however determined. In situations where resources for SEA are limited (Penrose 2003), cybernetic evaluation can help identify leverage elements offering the greatest effect and payload ratio. More importantly, the relative number of negative feedback loops should be higher than those of positive ones. This is critical in consistently self-correcting in a manner that avoids over-development in any one dimension. For example, if mitigation has been done poorly, this will be picked up at any of the several hold points, and a swift trigger executed so that the anomaly is corrected. Long feedback loops with many intermediate stages hint at repercussions with a time lag, and should therefore be avoided in order to be efficient and responsive within the shortest time possible.

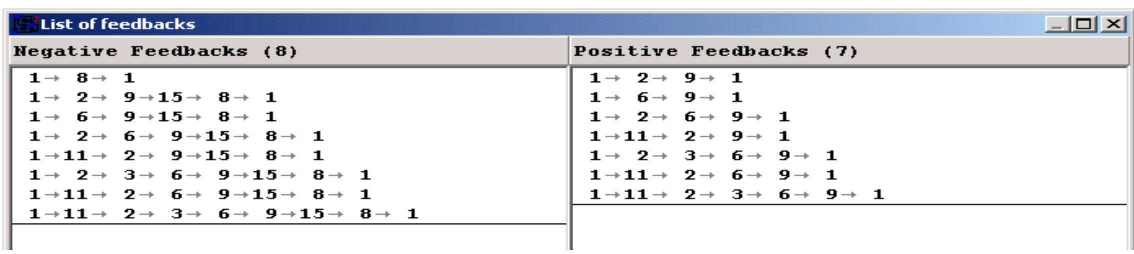


Figure 7.6: List of negative and positive feedback loops

7.2 Summary of results and findings

In summary, the following findings have been distilled from the cybernetic analysis of the portrayed UK SEA system:

1) Context, and not procedure elements, were most effective leverage elements in terms of systematic achievement of EI.
2) The most active and most influential elements in relative achievement of EI are Political Will and Public and Civil Society Awareness. The existence of Environmental Objectives, National/Sector environmental objectives and SEA Framework were weak leverages.

3) The least effective in relative achievement of EI were the Evaluation of PPP alternatives, Decision-making and Review of the SEA report, Mitigation and Monitoring and Evaluation. This does not contradict the opinions found in existing literature, although it has been herein revealed that the relative effectiveness of these elements is not as high as portrayed.
4) A group of background variables that can affect other variables but cannot be affected by them can be identified. For example Political Will and Planning Systems framework can affect other elements but not the other way round.

5) The SEA system is more open than closed, and contains several elements that are affected by external influences to a significant degree. It needs to become more closed and have increased interconnectedness and degree of networking.
6) The SEA system needs more and short negative feedback loops and/or improvement of the quality of the existing ones e.g. allow faster trigger and response within the system.

7.3 Scenario simulations

The objective of this section is to present the results of the various simulations done to depict how SEA elements interact in achieving various levels of EI, as described in section 3.5. The settings for the simulated scenarios are presented and the subsequent simulation results provided. A graph depicting the results of each simulation is also provided followed by interpretation and significance of the simulation results.

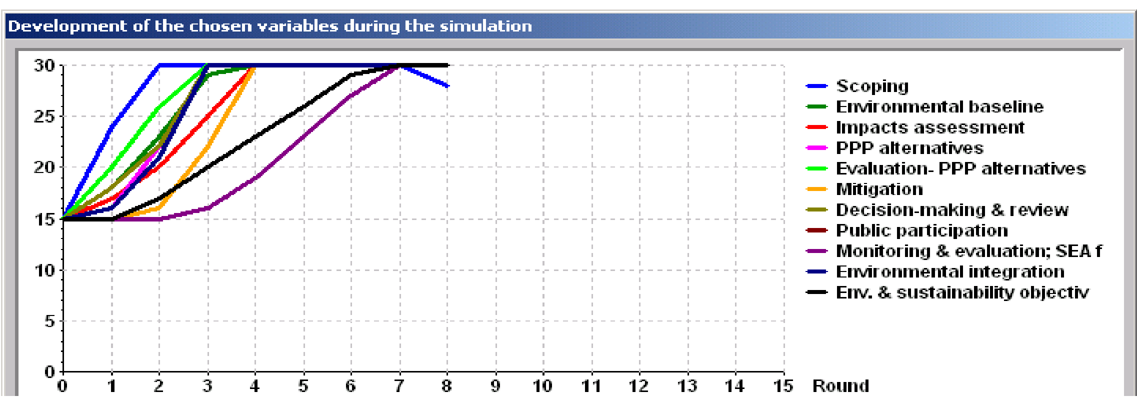


Figure 7.7: Exploratory simulation

Scenario settings: All parameters at medium level

Results and interpretation: All parameters rise steeply, confirming tendency of system to cumulatively develop in the same direction (Figure 7.7). Scoping, Environmental Baseline, Decision-making and Review and Evaluation of PPP alternatives were first to increase, and others reacted in tandem. Monitoring and Evaluation (M&E) was slowest to respond positively. EI builds up ahead of Environment and Sustainability objectives and M&E, although closely in tandem with Mitigation and Impact Assessment. Certain optimum procedures e.g. optimum Impact Assessment, Identification of PPP alternatives, PPP alternatives Evaluation and Mitigation can in fact compensate for environmental and sustainability objectives. This is because they will develop the appropriate objectives by which to make evaluations and decisions. Such a compensatory exercise, however, may be costly and time-consuming, and may in practice not be cost-effective; hence having a set of existing environmental and sustainability objectives may in the long-term be indispensable. The medium level for all parameters is portrays a threshold zone where EI and all other SEA elements improve with time, revealing a zone where the system over-develops.

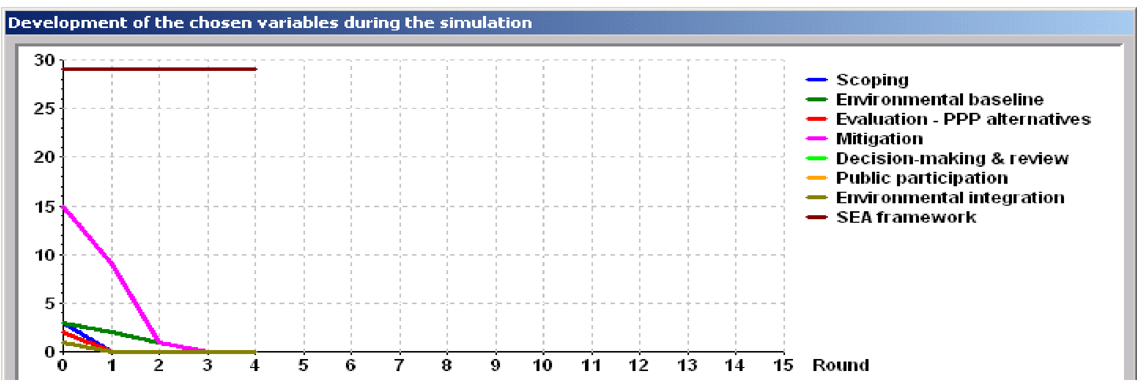


Figure 7.8: Exploratory simulation – mitigation

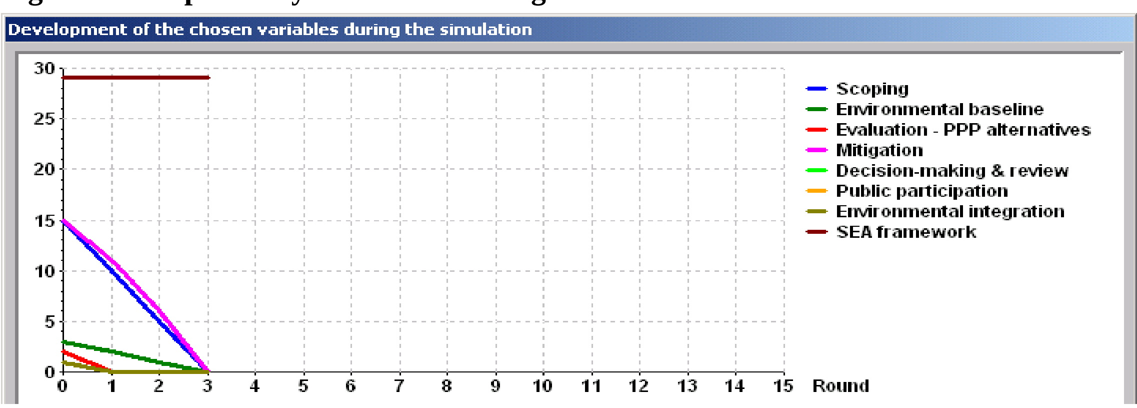


Figure 7.9: Exploratory simulation – mitigation and scoping

Scenario settings for Figure 7.8: SEA Framework (optimum); Mitigation (medium); others (very low)

Results and interpretation: All parameters crash, while the SEA framework maintains its optimal level. This indicates that the thresholds and zones where corrective feedback mechanisms are triggered have not been reached. Adjusting Scoping to medium level did not change the results (Figure 7.9), with no self-correction coming from the added combined effect of the two elements being set at medium level. This implies that low levels of SEA parameters will cumulatively produce low EI, and medium level Scoping and Mitigation under these conditions, are not enough to trigger self-correction. Therefore, focus on remedial action need to consider the least number of interconnected SEA elements, to at least reach the minimum threshold for self-correction. Since collapse was rapid, remedial action would require short feedback loops and be instigated immediately, in order to avoid collapse of the system.

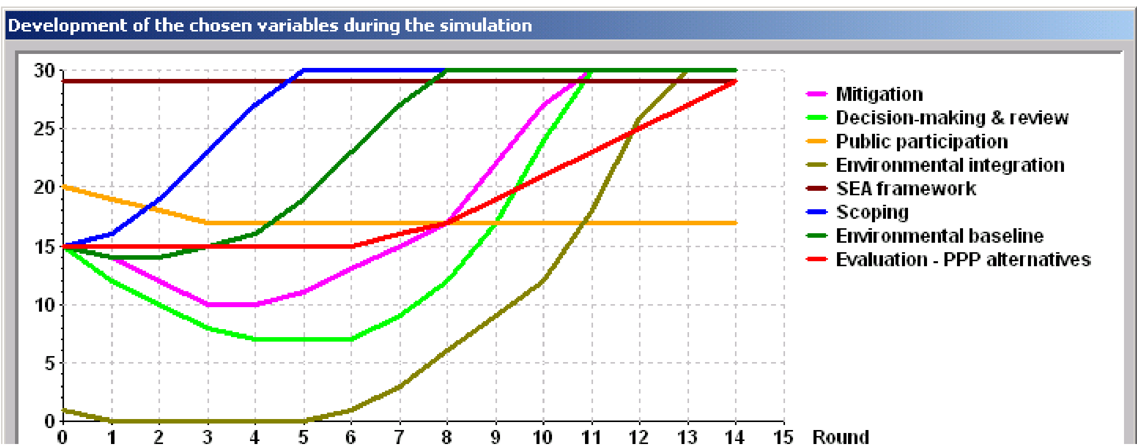


Figure 7.10: Exploratory simulation – effect of very low EI

Scenario settings: SEA Framework (optimum); Public Participation (sub-optimum); Decision-making and Review, Mitigation, Evaluation of PPP alternatives, Scoping, Environmental Baseline (medium); EI (very low).

Results and interpretation: Scoping improves rapidly and all other parameters follow gradually, at various rates, except Public Participation that dropped towards middle level and stagnated. It dropped slightly towards medium level, and remained unchanged, because the M&E loop was not included in this simulation. Initially, parameters dipped because of the cumulative impact of four parameters being sub-optimal. After considerable lag of four to five iterations, all other elements were gradually uplifted, taking several iterations to finally achieve optimum EI. In a situation where EI is initially very low, self-correction appears to take long and EI reaches optimum level after 12 iterations. This hints that if EI is to be assured, especially when EI is initially very low, the SEA elements must at least be above the medium level. Furthermore, the trigger for the self-correction process must be shortened and/or quickened, as iteration 12 is unrealistically long in practice.

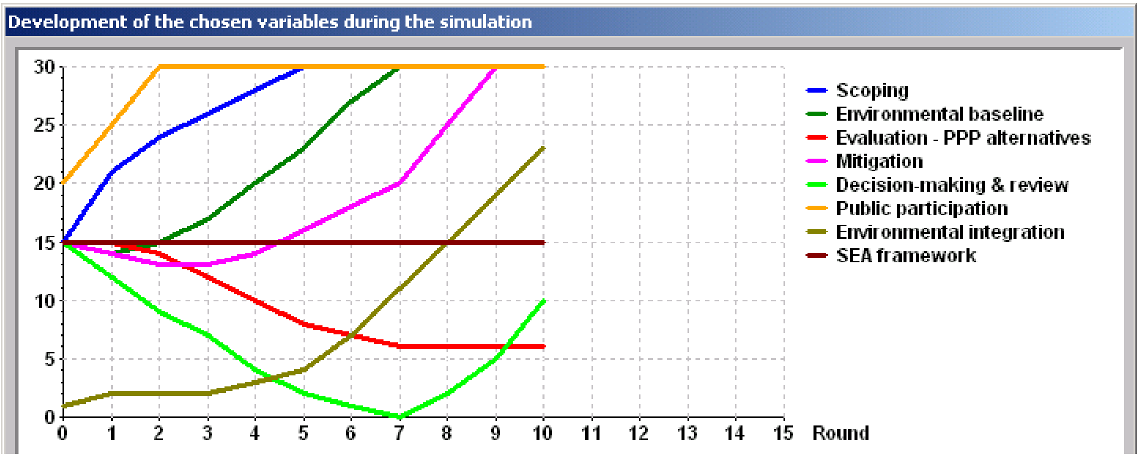


Figure 7.11: Exploratory simulation – effect of low SEA framework on simulation 7.9

Scenario settings: Public Participation (upper medium); Decision-making and Review, Mitigation, SEA Framework, Evaluation of PPP alternatives, Scoping (medium); EI (very low)

Results and interpretation: Public Participation, Scoping and Environmental Baseline improved gradually, followed by Mitigation. Falling Decision-making and Review affected Mitigation, Environmental Baseline and Evaluation of PPPs immediately, but as other parameters (Public Participation, Scoping) gradually reached optimum levels, they counter-balanced, and Mitigation, Environmental Baseline and EI improved steadily. Nevertheless, once most parameters generally improved, they had a positive cumulative effect and gradually increased EI. With most elements at optimum, then EI can be improved even when Decision-making and Review is low. This means that other elements can cumulatively make-up for poor Decision-making and Review, e.g. if Mitigation, Environmental Baseline and Public Participation are optimum. Improvements on most SEA elements occurred slightly faster than in scenario 7.10, as EI reached optimum level only after iteration 11.

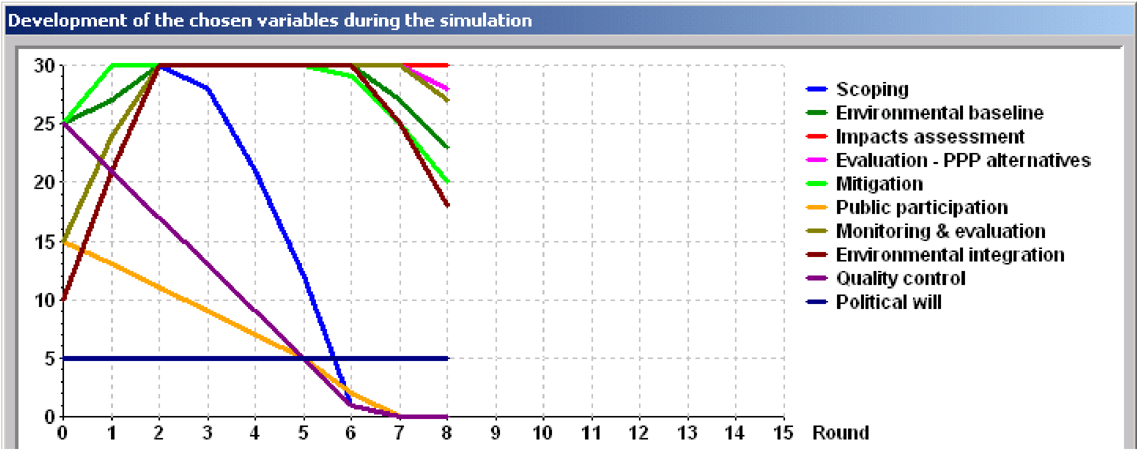


Figure 7.12: Exploratory simulation – effect of Political Will

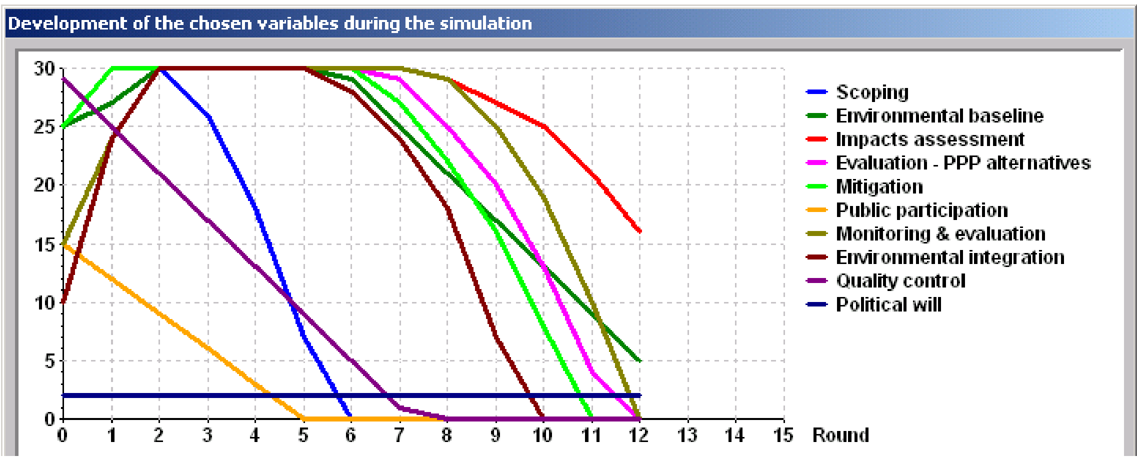


Figure 7.13: Exploratory simulation – effect of Political Will and Quality Control

Scenario settings for Figure 7.12: Quality Control, Mitigation, Environmental Baseline (optimum); M&E, Public Participation, EI (medium); EI (lower medium); Political Will (very low).

Results and interpretation: Decision-making and Review, Public Participation and Scoping sharply dropped, and after a lag, Quality Control also dropped. Thereafter, all parameters rapidly crushed. Political Will was a key trigger, and once key parameters like Scoping and Quality Control were low, the other parameters could not collectively correct the system. Even the parameters that had reached optimum were negatively impacted in the long run. Adjusting the Quality Control to optimum did not change the results (Figure 7.13). In the long-term, all elements were negatively affected and parameters rapidly drop for nearly all. A low Political Will triggered the fall, which then over-developed, and the parameters of elements plummeted. However, low Quality Control seems to reduce Scoping only after iteration number four, implying that in such a situation, corrective mechanism should be time-sensitive and kick in before the fourth iteration. Political goodwill is critical for long-term stability of the SEA process.

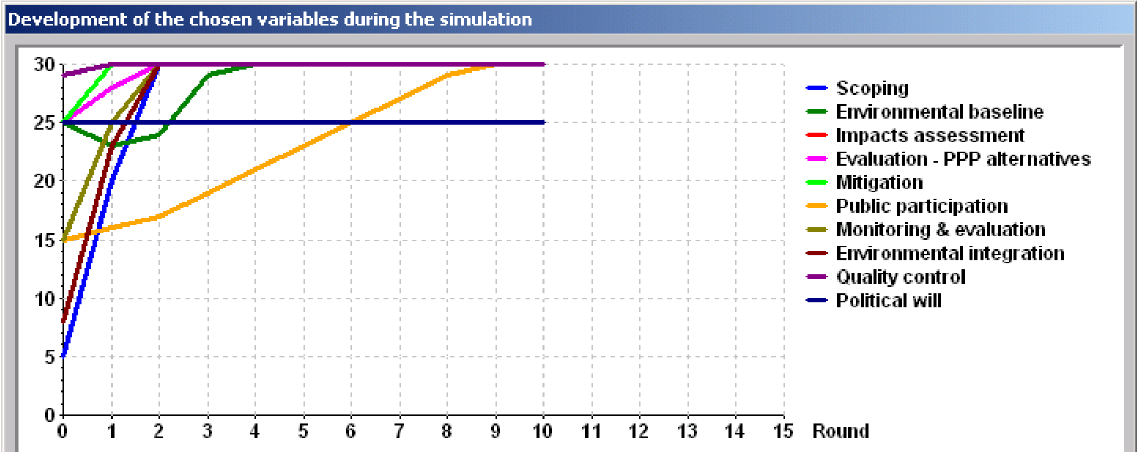


Figure 7.14: Exploratory simulation – effect of Political Will

Scenario settings: Quality Control (optimum); Mitigation, PPP evaluation, Political Will, Environmental Baseline (sub-optimum); M&E, Public Participation (medium); EI, Scoping (low)

Results and interpretation: Sub-optimum Political Will, Mitigation, PPP evaluation and Environmental Baseline combined with optimum Quality Control to rapidly and positively improve all other low parameters, except Public Participation. Public Participation was unnecessary in the improvement of EI, while Political Will need not be at optimum as long as an appropriate threshold has been met. It is revealed that Environmental Baseline can obtain within a zone of sub-optimality without hindering EI from being achieved at optimum levels. The level of Political Will appeared not to have any influence on the establishment of the Environmental Baseline.

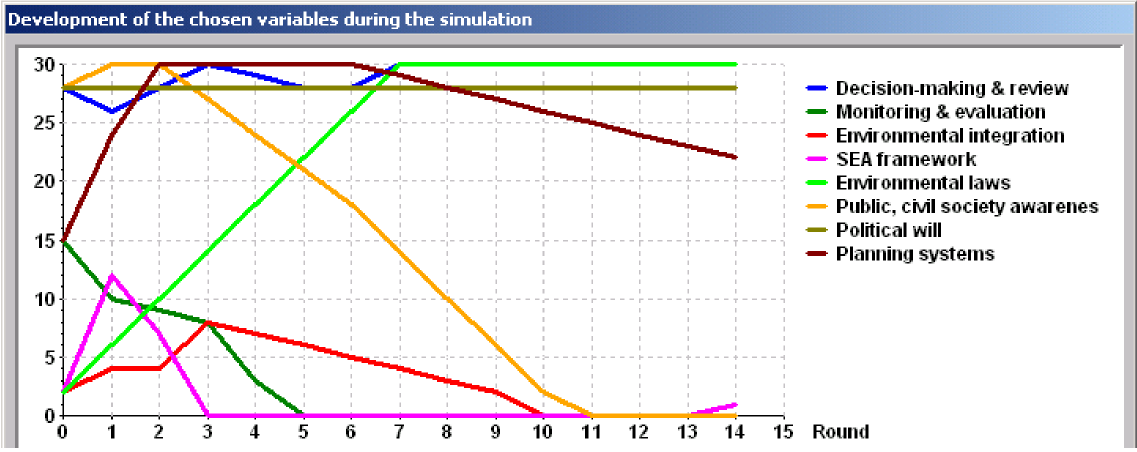


Figure 7.15: Exploring context parameters

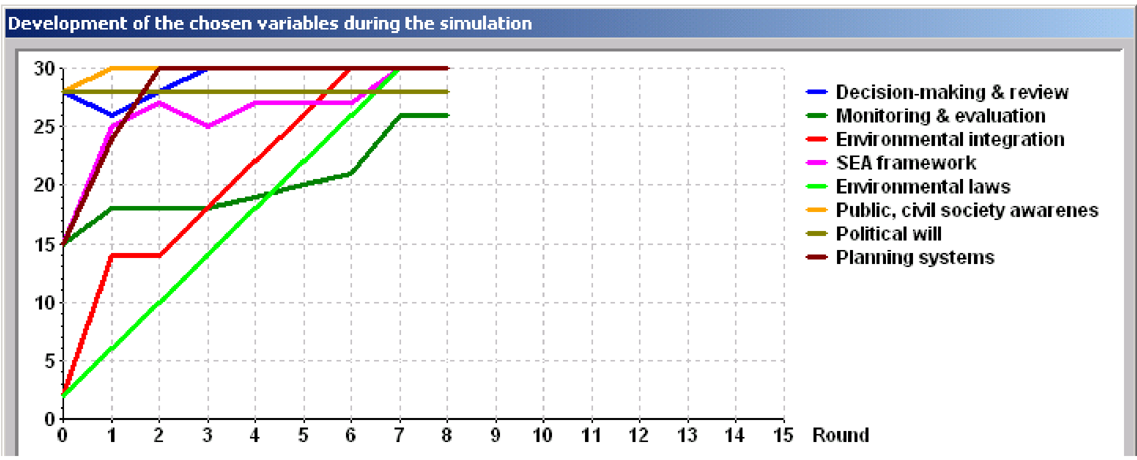


Figure 7.16: Exploring context parameters

Scenario settings for Figure 7.15: Public and Civil Society Awareness, Decision-making and Review, Political Will (optimum); M&E, Planning Systems (medium); SEA Framework, EI, Environmental Laws (very low)

Results and interpretation: Planning Systems improved rapidly to optimum level, but after 6th iteration gradually slipped towards medium. EI and SEA Framework dropped, as well as M&E and Public and Civil Society Awareness. The combined effects of initial conditions of poor SEA Framework, Environmental Laws and EI, combined with a condition of very low M&E, resulted in very low EI and Public Participation, even when Political Will and Environmental Laws had improved to optimum levels. When M&E was improved to medium position (Figure 7.16), then EI was positively impacted and steadily improved. It seemed critical in shifting the system from Figure 7.15 to Figure 7.16, confirming that when certain threshold parameters are met, the system will self-correct, over-develop and stagnate at new levels.

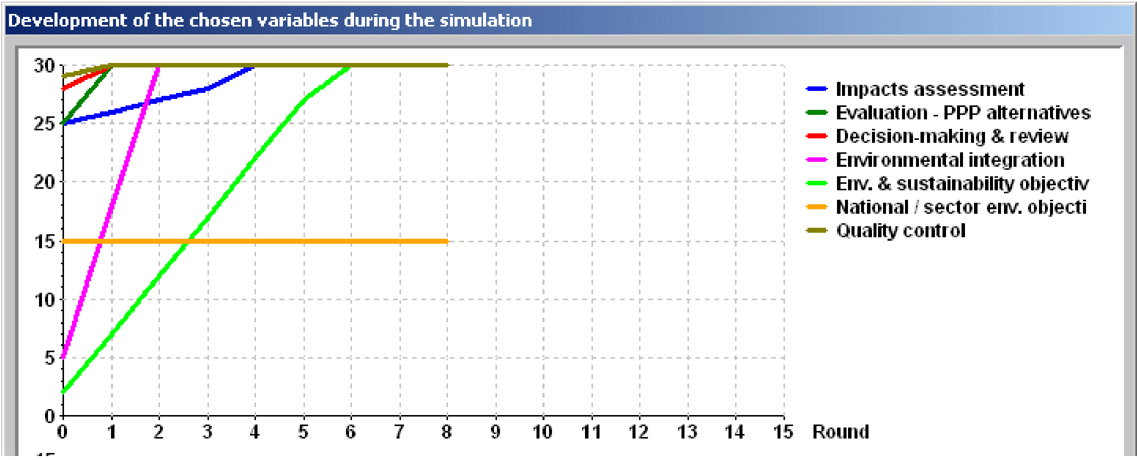


Figure 7.17: Exploring context elements – Environmental and sustainability objectives

Scenario settings: Decision-making and Review, Quality Control (optimum); Evaluation of PPP alternatives, Impact Assessment (sub-optimum); National/Sector environmental objectives (medium); EI, Environmental and Sustainability objectives (very low)

Results and interpretation: EI immediately rose; followed by Environmental & Sustainability objectives, to maximum levels, while National/Sectoral environmental objectives remained at medium. As long as certain key parameters were at optimum levels, then existence of environmental and sustainability objectives were compensated for.

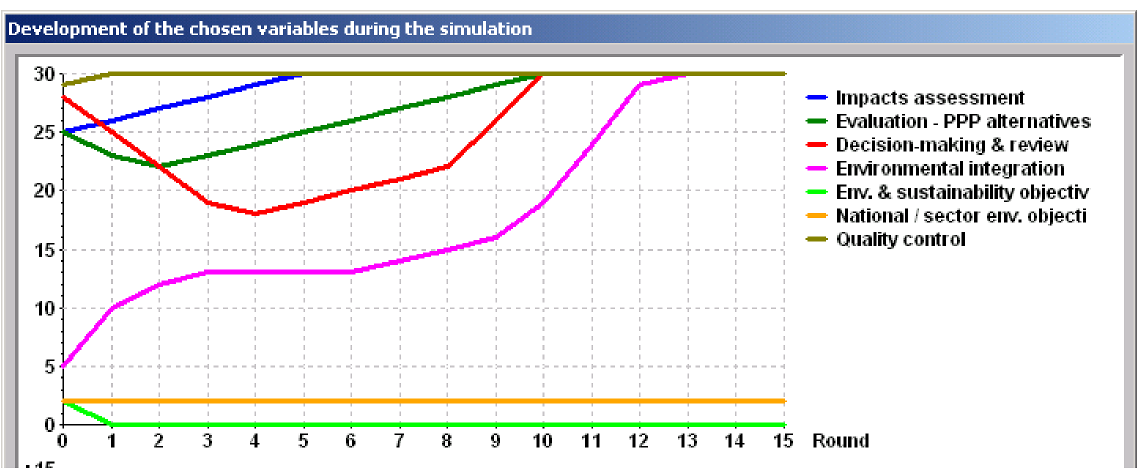


Figure 7.18: Exploring context parameters - Environmental and Sustainability objectives

Scenario settings: Quality Control, Decision-making & Review (optimum); PPP alternatives evaluation, Impact Assessment (sub-optimum); E (low); National/Sectoral environmental objectives, Environmental & Sustainability objectives (very low).

Results and interpretation: Very low level Environmental Objectives dragged down Decision-making and Review and the evaluation of PPP alternatives, until combined impacts of Decision-making and Review, PPP evaluation and Impact Assessment triggered stabilization and improvement. This occurred late, between 3rd and 8th periods of SEA iteration, and their combined effects made EI immediately rise to the optimum. Compared to scenario in Figure 7.17 the low quality of both National/Sector and Environmental/Sustainability and objectives led to EI taking nearly six times as long to improve from low to optimum. This implies that while national and sectoral environmental objectives can be circumvented by say optimum Quality Control, in the final analysis, the process was unrealistically too long. SEA processes may not take this many iterations in reality hence this scenario leads to the conclusion that environmental objectives cannot be done away with and are necessary in the achievement of EI.

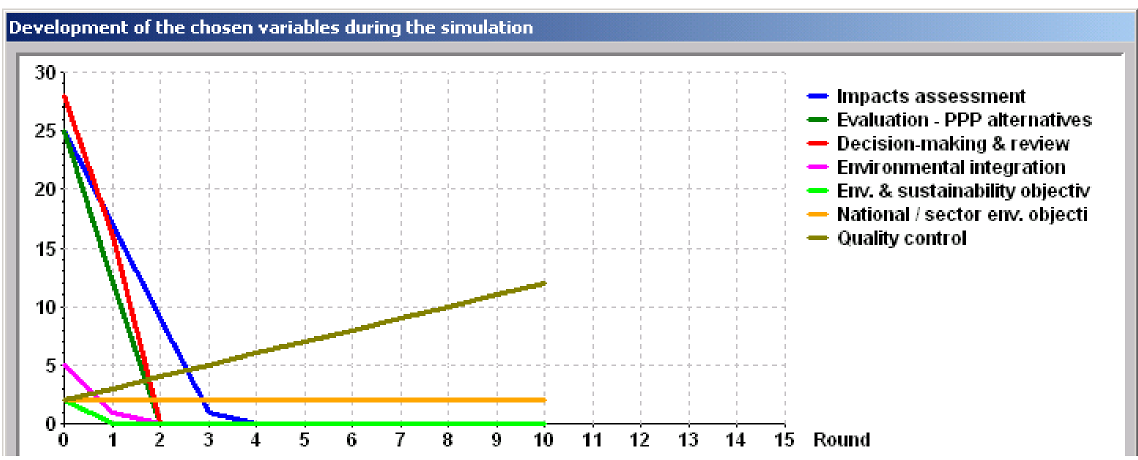


Figure 7.19: Quality Control and Environmental and Sustainability objectives

Scenario settings: Decision-making and Review (optimum); Impact Assessment, PPP alternatives evaluation (sub-optimum); EI (low); Quality Control, Environmental objectives, National/Sector environmental objectives (very low)

Results and interpretation: If Decision-making and Review, Impact Assessment and PPP alternative evaluation fall to very low levels, then even the effect of gradually improving Quality Control failed to compensate in a scenario where EI was already low. The system failed to self-correct. There was inadequate feedback loops because M&E was missing from the scenario, and Quality Control seemed completely independent and unconnected to other elements. Alternatively, Quality Control may have weak and/or ineffective feedback mechanisms capable of triggering for self-correction

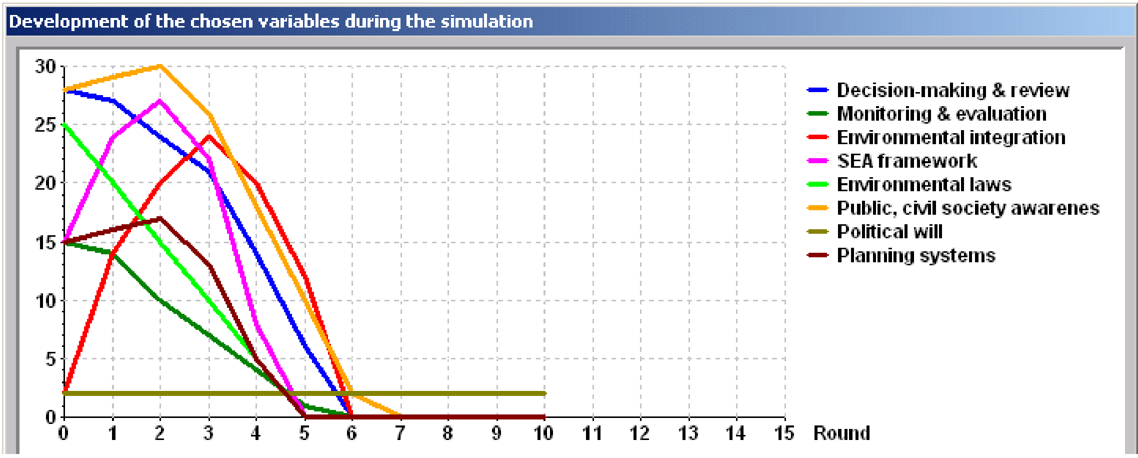


Figure 7.20: Influence of low Political Will and M&E

Scenario settings: Decision-making and Review, Public and Civil Society Awareness (optimum); Environmental Laws (sub-optimum); SEA Framework, Planning Systems, M&E (medium); Political Will, EI (very low)

Results and interpretation: The combined effect of very low Monitoring and Evaluation and low Political Will is strong enough to rapidly collapse all other parameters, and eventually EI. While the system is positively influenced by the optimum starting conditions, this positive growth peaks rapidly, followed by a rapid decline of all parameters. Environmental Laws were the first to drop while Public and Civil Society Awareness was the last to drop. Generally, the scenario unfolded rapidly and by the 4th period the full scenario had essentially played out, attesting to the strong effects of the influential parameters. The key finding from this scenario is that for EI to be achieved, the system should not have a situation where both Political Will and Monitoring and Evaluation are performed at very low levels. Optimum SEA Framework and Environmental Laws did not seem to compensate, and even where optimum Decision-making and Review and Public and Civil Society Awareness was optimum, these did not correct the situation and result into achievement of EI.

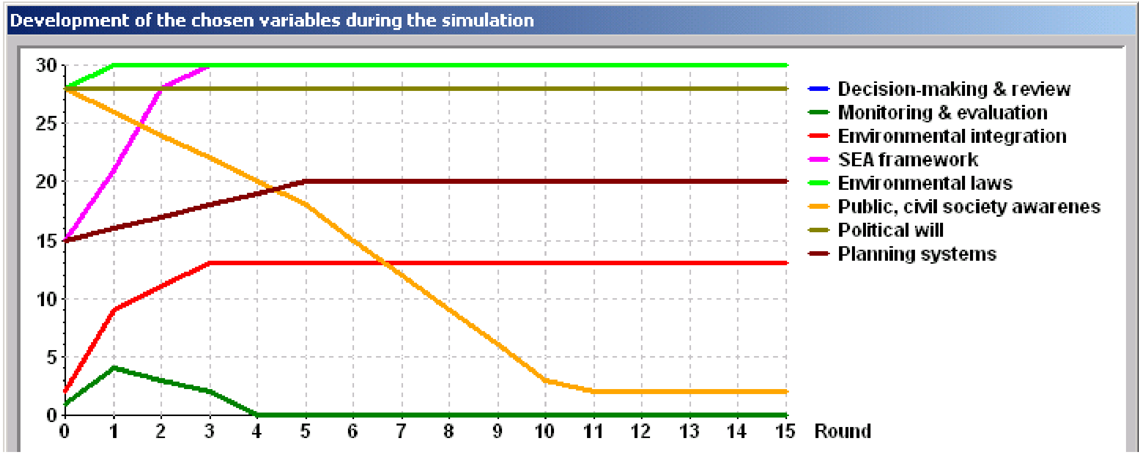


Figure 7.21: Dynamics between M&E and Public and Civil Society Awareness

Scenario settings: Public and Civil Society Awareness, Political Will, Environmental Laws (optimum); SEA Framework, Planning Systems (medium); Monitoring and Evaluation, EI (very low)

Results and interpretation: Environmental Laws and SEA Framework improved to optimum; Planning Systems, Monitoring and Evaluation and EI immediately rose and stagnated; except Monitoring and Evaluation that briefly rose then crashed. However, Public and Civil Society Awareness rapidly and steadily crashed in tandem with Monitoring and Evaluation. It is revealed that feedbacks among these elements are poor, hence the tendency to over-develop. For example EI and Monitoring and Evaluation were not influenced at all after the 4th period of iteration, indicating that there were not enough mechanisms to do so. Monitoring and Evaluation is a strong and almost only feedback mechanism for influencing Public and Civil Society Awareness. Even when Political Will was optimum, the Monitoring and Evaluation channel was critical in conveying this effect to Public and Civil Society Awareness.

7.4 Summary of results and findings

It was demonstrated that while SEA procedures mentioned in SEA literature are critical for achieving EI, from a systems perspective, the effectiveness of merely tweaking individual elements is not guaranteed. Within this context, it was revealed that first understanding the cybernetics, and consequently, the leverages and instrumental roles of elements *within a contextual SEA-EI system*, is prerequisite to actually identifying which, and to what extent, certain SEA elements will be effective in delivering EI. For example, in an SEA system where certain elements are below a threshold, then it matters little if only Scoping is improved to an optimum level. Rather, several elements will have to be simultaneously improved to above a certain threshold, for the system to self-correct in delivering EI. It is important to recognise that certain *thresholds* must obtain in a specific *minimum* number of SEA elements in order for that system to function as a self-correcting dynamic entity.

It has emerged that the starting conditions of a system are important to determining its evolution, and therefore, the potential leverage points to influence the system. From simulations where EI was very low, it was critical that optimal Monitoring and Evaluation was established, regardless of how well the other elements were improved. It appears that Monitoring and Evaluation provides the communication channel that can iteratively correct the situation; without it, the system does not receive the adequate stimulus and trigger for self-correction. Figure 7.20 showed how starting conditions with all elements except Political Will set between medium and optimum levels, led to a crush after the 3rd period. The single element of Political Will, in this scenario determined how the system developed. Yet in a contrasting scenario (Figure7.16), not only Political Will but SEA Framework had to increase in order for an increase in EI to be achieved.

While Political Will is important in the system delivery of EI, the role of Monitoring and Evaluation strongly determines whether Public and Civil Society Awareness is positively or negatively affected. This means that Political Will is not enough by itself; M&E is required as a feedback channel through which Public and Civil Society Awareness is impacted. Therefore, BOTH need to be promoted concurrently, observing their qualities and threshold levels in order to trigger effects. The Monitoring and Evaluation function must be kept at a threshold in order to act as effective conveyance between Political Will and Public and Civil Society Awareness.

In order to increase the UK SEA system's capacity to self-regulate, it is critical that an adequate set of preferably several *short and effective* connecting negative feedback loops be added, otherwise inertia or one-dimensional developments within SEA parameters will prevail. Currently, there are several links of negative feedbacks (Figure 7.6) where SEA elements remained significantly un-influenced by other system elements; and feedback loops where the elements did not exert or have mechanism to convey significant influence upon others (see Figure 7.21). If systematic delivery of EI is a key objective of SEA, then it has been revealed that several SEA elements have inadequate negative feedback loops within and among them. Furthermore, instances in which existing feedback mechanisms were too slow or weak exist (see Figures 7.13 and 7.18). This can be as a result of long feedback loops as revealed in Figure 7.6, or feedback loops that are poorly executed. This for example means that an opportunity for quality review is not carried out according to satisfactory standards; hence its feedback effect is low.

In conclusion, sensitivity analysis revealed the hitherto hidden dynamics and inter-relationships within SEA as a system. By enhancing the understanding of SEA as a systematic process, a basis to overcome the one-dimensional approach to understanding effectiveness in SEA elements in achieving EI is provided. A systems-wide approach has un-packed and offered further insight into the dynamics of a complex SEA system. Applying sensitivity analysis has revealed the conditions within a multi-dimensional SEA system in terms of their thresholds and tipping points. Sensitivity analysis has proved effective at capturing complexity and numerous detailed data within the contexts of simulated scenarios. Based on the results of cybernetic evaluation and simulation, some commonly held opinions about SEA system and elements were revealed as either incorrect or partly inaccurate. For example, while SEA experts generally thought that improving single elements such as Scoping and Public Participation was enough to achieve EI, sensitivity analysis revealed there was more complex dynamics around them than single element interrelations. It has therefore been confirmed that SEA suffered same errors (false description of goals, one-dimensional analysis of situations, irreversible fore-grounding, neglected side-effects and over-steering) often applied to approaching and managing complex systems, as explained in section 1.2.2. Consequently, the new insights into SEA's systematic behavior provide a valid and empirically tested basis for enhancing theory-building, as argued in sections 1.2 and 1.5 of this dissertation. The SEA system remains to have its cybernetic properties and parameters improved, if it is to systematically deliver EI through negative feedback loops.

PART IV.

IMPLICATION OF RESULTS AND FINDINGS

"*It is a wonderful feeling to recognize the unity of complex phenomena that to direct observation appear to be quite separate things*".

Edward O. Wilson (1998 p 5)

Chapter 8: Analysis and Discussion of Results

This chapter draws together the results of the research by applying deductive, inductive and triangulation analysis, in interpreting the results in terms of the research objectives. Subsequently, a summary of the findings from the analytical framework is presented; and how they address the research questions stated in section 1.3, explained.

8.1 Deductive analysis

The deductive research approach tested and verified the hypotheses outlined in this research, according to which: 1) A higher presence and quality of SEA procedures results in higher EI scores; and 2) certain clusters of SEA elements are more associated to delivering EI than others. The hypotheses verification was achieved through the correlation coefficients and their associated levels of confidence. On the first hypothesis, the very low correlation scores between SEA scores and EI scores led to the inference that there was both insufficient and statistically insignificant evidence to support it. Six various SEA scores (Table 2.3) and nine various ways of calculating EI scores (Table 2.4) did not produce any statistically significant correlation between them. The Spearman's rho and Kendall's tau_b scores were consistently below 0.3 in all cases, and were not statistically significant at 95% and 99% levels. This led to the conclusion that based on the 47 UK SEA samples it was not demonstrated that higher scores for SEA process and its procedures were significantly correlated to higher EI scores. Deductively, it was concluded that there was no evidence to confirm that higher SEA scores corresponded to higher EI scores; and no statistically significant data emerged to confirm that a specific cluster of SEA procedures was correlated to high EI scores. Therefore the second hypothesis that a certain cluster of SEA elements was more associated to delivering EI than others was not confirmed.

While literature suggested that Scoping sets the scope and scale for other SEA elements, and therefore significantly influences quality of other elements (Therivel 2004), the low and insignificant correlation scores deductively led to the conclusion that there was no convincing evidence to support this stance (see Table 6.1). Nevertheless, there was no evidence to refute that Scoping contributes to the determination of the quality of an SEA process. Whilst Scoping was moderately correlated to two out of seven elements i.e. Mitigation and Monitoring and Evaluation (Table 6.1), Scoping correlation data was below 0.3 with the other 5 elements. In reference to the SEA aggregate scores, Scoping was not correlated to any other

SEA element. Furthermore, correlation scores between SEA elements such as Public Participation and others were below 0.3 in all cases.

8.2 Inductive analysis

This approach looked at the validity of previously stated claims of SEA achievement of EI, and provided the basis for interpreting the patterns observed from the questionnaire survey, sensitivity analysis and making generalizations from the results of correlation analyses. At an adjusted response rate of 24.36% the questionnaire findings were deemed representative of UK SEA, at least within the sectors represented in the SEA samples. This represented 80% respondents split into SEA academics and SEA practitioners at 40% each. 46% of the SEA samples came from Development Plans and 20.35% from Transport Plans. Waste, agriculture, land use and energy sectors were poorly represented in the study sample, as were SEA administrators among the UK SEA expert sample. The questionnaire response rate in this study was considered comparable to a questionnaire survey applied by Gazzola (2006) in which the response rate was 21.4% and the adjusted response rate was 25.11%. Therefore, the patterns deciphered from the questionnaire survey results were deemed reliable representations of prevailing attitudes and opinions of UK SEA experts on the research issues. Consequently, results from questionnaire survey provided a basis from which other results could be explained and inferences into the larger UK sample, extrapolated. The questionnaire survey results also provided a reference on which to project and compare results obtained from the quantitative evaluations of SEA and EI. For example, the procedural definition of EI as revealed by the questionnaires enhanced the understanding of why the quality of SEA procedures was more correlated to SEA scores, than procedure presence or procedure output quality scores. It was induced that this is because the SEA experts largely defined EI as a procedural process of “balancing between environmental and socio-economic aspects” and “complying with legislation” (section 5.1). Therefore more emphasis was apparently put on the quality of SEA procedures as opposed to quality of the outputs of the procedures.

The trends revealed within the voting patterns of the questionnaire survey were inductively analysed and new views and potential hypothesis generated. For example Net Effectiveness as an indicator of overall opinion of respondents on various issues, confirmed that there is a slightly positive but tenuous attitude towards the application of quantitative evaluations in SEA and EI. About 8% agreed that quantitative evaluations be applied in both SEA and EI; 58% agreed in only SEA against 44% for only EI; while about 34% indicated that no methodology existed for quantitative evaluation in both SEA and EI. No one indicated that quantitative evaluation in SEA was possible but lacked adequate method; while about 12% indicated that while it was possible to apply quantitative methods in EI, appropriate methods were lacking. It was therefore concluded that the general indication was that quantitative methods found slight support as an appropriate tool in SEA and EI, mainly because the strategic natures of both SEA and EI were not amenable to quantitative methodologies. Nevertheless, only researchers were in the category that advocated for quantitative evaluation in all SEAs and EI. While this percentage may indicate a notable variation of opinion along expertise and occupation, in reality, the absolute number of the researcher respondents was too low to infer a reliable meaning.

From the consistent high percentage of UK experts who are ambiguous on SEA cause-and effect pathways, relative to the small percentage of those who are certain, it was inferred that there was need for further revelation of explanatory facts around SEA delivery of EI. This confirmed the validity of an introductory premise in this thesis that in spite of qualitative evaluations (section 1.1), a research gap to be filled by providing empirical insight into those areas as yet unsubstantiated, remained.

From inductive reasoning, based on patterns from questionnaire surveys and simulations, new postulations are proffered. For example, that the one-dimensional approach to SEA effectiveness has had an inordinate emphasis on the efficacy of single SEA elements, even though the elements do not function in isolation from each other. Rather, the SEA elements would have to be perceived within the context of dynamic interplay within multi-dimensional spheres of influence, in which the elements differentially influenced each other, with time. The elements' effectiveness was adequately and more realistically depicted from a systems approach in which influences from other elements and factors are accounted for, than from single element analysis approaches. Data patterns from cybernetic evaluation have illustrated this, as well as simulation graphs in Chapter seven.

From analysing the cybernetic data and simulation graphs, the patterns revealed that several SEA elements purported in SEA literature to be effective in achieving effectiveness failed to live to expectations under further scrutiny by sensitivity analysis. The *Index of Influence*

(Figure 7.3) that determines which elements are critical in achieving EI, produced scores that showed that several other SEA elements (Impact Assessment, identification of PPP alternatives, Public Participation, Quality Control, establishing Environmental Baseline and Public and Civil Society Awareness), were more critical to influencing the achievement of EI, than Scoping. Furthermore, Scoping was consistently shown in the simulations not to be singularly as critical as initially stated, in achieving EI. Figures 7.8, 7.9 and 7.10 demonstrated this by showing that where several SEA system parameters were low, improving Scoping to an optimum level was not enough to deliver EI. However, when several other elements and parameters were improved, then Scoping played a significant role in the subsequent achievement of EI.

Since no cluster of SEA elements consistently registered a strong, high or significant correlation with any EI scores, the second hypothesis that a cluster of elements were most correlated to EI scores, was therefore rejected. This conclusion was inductively reached, as no pattern emerged in which any two elements were repeatedly correlated to any EI score(s). No repeated patterns from correlation and sensitivity analysis revealed such association. While Partidario and Clark (2000) proposed six basic elements for SEA exercise to be effective, i.e. Public Participation, Guidelines of good practice, Consultations, Independent Oversight and Review, evidence emerging from simulations indicated that the relationships and interactions were underpinned by non-deterministic and dynamic behaviour. No identifiable patterns from cybernetic analysis as well as simulation analysis supported the existence of such a cluster of SEA elements, as consistently critical in determining SEA quality. While elements such as Political Will, Scoping and Monitoring and Evaluation (M&E) were influential in one scenario, it was not necessarily so in another. In various scenario simulations, the contingent elements were not predetermined, but decided by context specific factors and conditions. For example, while M&E may be essential to affect EI, it matters that it exists at a threshold level, and in a context where other relevant parameters obtain; otherwise EI was not realized. In conclusion, from analyses of patterns from correlation analysis and sensitivity analysis, the assumption that a set core of SEA elements was conducive to achievement of EI was clearly not confirmed as valid.

Furthermore, generalizations arising from the patterns observable in the results from UK SEA sample samples, which are likely to hold in the larger populations, were made. The patterns of descriptive statistics were a basis for confidence in generalizing and extrapolating results to wider samples. Generalisation or reasoning from detailed facts to general principles is the inductive process of formulating general concepts by abstracting common properties of instances. Following the effect matrix, AS (Active sum) and PS (Passive sum) scores, and simulation results, new generalizations could be made concerning SEA as a systemic process. For example, the delivery of EI is a product of the dynamic *interplay between several elements, at various levels, within various contexts, and not merely of a predetermined set of elements*. It also can be generalized that M&E, when performed to a threshold, is a key determinant of the self-correcting potential of the SEA system. Finally, it can be generalized that for any SEA system to self-correct promptly, a number of short cycle feedback loops are required. This was evident in the long periods of correction undergone in certain scenarios; an event that in practice was too long to have any useful purpose, hence need for such correction to take shorter periods.

Within the context of SEA systematic nature, generalizations may be valid within the international context *to the extent that the SEA elements are largely similar* to those found in the UK. This is because based on the sensitivity analysis and correlation analysis, there is no reason to believe that the SEA elements would interact any differently in the international arena. This concedes that while strengths of element effects may vary in various SEA systems, the nature of association may not be different. For example the interaction between establishment of Environmental objectives, Scoping and Monitoring and Evaluation may be similar in all SEA systems, albeit to various degrees. Furthermore, current international SEA literature has been largely influenced by European SEA experiences (Gazzola 2006), of which the UK case study is a sample. Therefore, it would be reasonable to expect the systematic nature of UK SEA significantly reflected in most other international arenas. In conclusion, the following general rules are postulated to apply, based on results from the UK samples:

1) That several SEA elements need to be simultaneously leveraged beyond certain threshold points, in order for the SEA system to function within effective feedback loops and avoid collapse or over-development;
2) That effectiveness of SEA elements in achieving EI is more a function of context, and determined within the initial parameters and dynamic interactions with other elements;
3) That EI is a product of the dynamic *interplay between several elements, at various levels, within various contexts, and not merely of a predetermined set of elements for delivering EI*.

4) That not all elements of effectiveness will necessarily achieve EI, at all times and in all contexts. The relevant leverages in each context must first be identified.

Induction has also been used to determine the most likely appropriate SEA elements for leverage in achieving EI and as priority for future research and resource allocation. This was based on the cybernetic evaluation of the SEA system where the roles and effectiveness of various SEA elements were identified. Furthermore, the dynamic interactions of SEA elements as revealed by the simulation graphs showed their potential roles in achieving EI under various conditions. Since two background elements (Public and Civil Society Awareness and Political Will) were identified as effective in achieving EI, but are not influenced from within, it is therefore proposed that they should be targeted as leverages of priority. From an effect analysis section (7.1), they scored high on Active Sum (AS), meaning that they potentially have a lot of influence in delivering EI. Therefore, if the effects from their leverage are expected to be high, it can be induced that payload is high as well. Therefore, in pursuit of cost-effective synergies by fine-tuning SEA elements in order to enhance EI achieved, it is imperative that significant resources be spent on those SEA elements known to correspond to greater cost-benefits, following cost-benefit analysis. Otherwise, from one-dimensional approaches, resources would go towards improving an SEA element even when it least achieved EI. By induction, the results of sensitivity analysis led to the conclusions that a consideration of system-wide functionality within the SEA elements holds the key to improving EI, as opposed to over-focusing on individual SEA elements in isolation. The simulation graphs depicted how every scenario evolved based on its initial parameters, within interplay with its elements; and not as a predetermined system driven by specific elements.

In situations where correlations between SEA procedures and EI have been found to be lowest, more focus and resources may be required, if only to bring them up to certain thresholds. However, the need to make efficient and effective use of resources may justify that correlation results be interpreted against sensitivity analysis findings, to avoid ineffective investments that do not improve EI. Since almost all SEA elements have at one time or another been identified as inadequate, and therefore in need of improvement in order to make SEA more effective, system-wide approach has the potential to decisively differentiate among the priority elements within a given context. Finally, the patterns that arose within the sector level correlations (see section 6.1) led to the affirmative conclusion that differences in correlation exist within sectors. For example, while the general SEA sample revealed a low level of correlation between Scoping and other SEA elements, within the Transport sector, there was strong and significant correlation between Scoping and other SEA elements.

8.3 Triangulation analysis

By cross-checking findings from the various methods, validity of results was enhanced when results from two different methods pointed to the same conclusion. Conversely, where results from one method contradicted those of another, validity was lowered and cautiously approached. For example, while questionnaire survey found that Scoping was thought to be effective in achieving EI, neither did results from correlation analysis nor sensitivity analysis reveal supporting evidence. Instead, sensitivity analysis revealed that Scoping was neither critical nor a key element for leverage; and that its effectiveness in achieving EI was contingent upon other elements. Furthermore, sensitivity analysis revealed that a critical number of elements was needed to at least be at certain threshold in order for Scoping to effectively influence the system. While effectiveness Scoping is not discounted altogether based on questionnaire survey, the insight on its role is modified and further understood anew, in relation to different results from the other methods. Similarly, validity of questionnaire survey results indicating that Public Participation and Consultations were effective in delivering EI was lowered by non-confirmatory results from correlation analysis and sensitivity analysis. Results from correlation analysis and sensitivity analysis revealed that Public Participation and Consultations were not necessarily and automatically effective, and that their effectiveness was contextual and depended upon other elements. Therefore triangulation provided a basis for modifying and qualifying the validity of the results from one method using those from the other two.

In scenarios where parameters of relevant elements were too low, then, Scoping could not on its own steer the system into self-correction. This was demonstrated by the cybernetic evaluation (section 6.1) as well as by the results of scenarios simulation (section 6.2); and indirectly enhanced by lack of correlation evidence to indicate that Scoping was critical in EI. The elements identified as poorly done under quantitative evaluation (i.e. establishment of Environmental Baseline, Mitigation, Monitoring and Evaluation, Reporting and Options Evaluation) were also revealed to be weakly correlated to EI. However, further analysis through the sensitivity analysis revealed that under certain circumstances, and when particular conditions and thresholds have been met, these elements could apply leverage and systematically improve EI (see section 7.3). Therefore, the poor correlation scores were partially supported by the simulation results indicating that zones of poor association do exist. Nevertheless, since zones of high association also exist when optimum conditions obtain, Triangulation has revealed that even these poorly-scored elements can at other times be significant in achieving EI. Therefore, triangulation did not foreclose the possibility of finding strong correlations between poorly done SEA procedures, and EI. Based on the above analytical framework, the results of the various methods were used in answering the three research questions stated in section 1.3, thus: 1) To what extent is the SEA process and EI amenable to quantitative evaluation? 2) To what extent are the claims embedded in commonly accepted SEA definitions valid? 3) What correlations and dynamics exist between and among SEA procedural and contextual elements, and how do they contribute to the achievement of EI? The answers are subsequently presented from sections 8.1 to 8.3. In section 8.4 the verification, and hence validity, of the two hypotheses held at the start of the research (section 1.1) is presented.

8.4 Extent SEA and EI are amenable to quantitative evaluation

It has been demonstrated that presence, quality and output quality of SEA procedures are amenable to quantitative evaluation. EI in terms of environmental objectives and indicators are also measurable quantitatively. The validity of these conclusions was confirmed by descriptive statistics of the data from quantitative evaluation, which indicated that the standard error was low and therefore the applied measurement instruments produced reliable data. Since the 95% confidence interval for the data means were within the limits of standard deviation, it was concluded that the quantitative approach provided data that was statistically reliable and reproducible. To the extent that SEA procedures and their quality output were reliably amenable to quantitative evaluation, the results proved useful in differentiating various SEA procedures (procedure quality) and their output (procedure output quality) into three distinct categories (section 6.5). At sector level, it was revealed that SEA procedures were differentially correlated and discrete categories could be identified at this level. In conclusion, quantitative evaluation provided relatively indicative results that differentiated SEAs based on evaluations of procedure presence, procedure quality and procedure output quality. Similarly EI was differentiated based on evaluation of statements of environmental objectives and indicators. Therefore, quantitative evaluation demonstrated its capacity to evaluate SEA and EI, subsequently facilitating hypothesis-testing, and thereby contributed to providing empirical findings that can enhance theory-building in SEA.

However, while correlation analysis and sensitivity analysis showed successful application of quantitative approaches to SEA research, opinion from UK SEA experts was still low on the usability of quantitative approaches of evaluation in SEA and EI; largely for fear that such methodologies would not capture the strategic nature of SEA. The experts admitted to seeing a role for quantitative evaluation in assuring quality of SEA procedures and EI achieved. Nevertheless, it has been demonstrated that the extent to which SEA process and EI are amenable to quantitative evaluation is significant and provides a basis to differentiate SEA and EI qualities. However, the practical significance of the quantitative scores is as yet unclear. This is because there is no clear interpretation of how the numbers relate to reality. In this context, a correlation that was found statistically significant cannot be assigned practical significance because it is not known what the quantitative number represents, in reality.

8.5 Verification of claims in SEA definitions

The validity of claims in SEA definitions that SEA 1) achieves EI and that 2) SEA is systematic, has been successfully tested and the conclusions are subsequently presented in subsections 8.2.1 and 8.2.2, respectively. The conclusions were drawn on the strength of the evidence from correlation analysis that tested for association between SEA procedures and EI, as opposed to testing for direct causality between SEA and EI. On the question of SEA process being systematic, the results provided by sensitivity analysis provided conclusive answers.

8.5.1 SEA fails to significantly achieve EI in UK PPs

The validity of the claim that SEA achieves EI in PPs was positively confirmed from the questionnaire surveys done by UK SEA experts. However, confidence in this claim was lukewarm with slightly more than 60% experts confirming that SEA achieved EI. Furthermore, the bases of their belief were undermined because a significant majority based their belief on anecdotal, rather than empirical, evidence. The correlation analysis, however, did not reveal any reliably supporting and significant evidence of correlation between SEA procedures and EI. Therefore, based on the results of correlation analysis, it is confirmed from this research that UK SEA procedures did not significantly lead to EI in PPPs. Nevertheless, sensitivity analysis revealed that the UK SEA system can achieve EI when certain SEA elements obtain at least at threshold parameters relevant to the specific context. When the SEA and EI scores were disaggregated according to sectors, similar results of no evidence supporting correlation emerged. Caution is however maintained, that although the results were statistically insignificant, it is not very clear as to what the practical significance of the low correlation scores are. This is because, in reality, the true critical limits of the EI hypothesis tests are unknown and may not correspond to the standard ones set in the analysis software.

8.5.2 Systematic nature of SEA is weak and poorly developed

From a cybernetic perspective, it is confirmed that SEA resembles a stubbornly stable system with poor feedback loops to enhance self-correction towards a certain range of EI. The SEA system is prone to over-development as well as crushing, particularly when several SEA elements are either above or below certain thresholds. The elements for potential leverage in certain contexts were identified, in terms of the active-reactive and buffering-critical potentials. It was revealed that contrary to prevailing international literature, effectiveness of SEA elements in achieving EI is not automatic and depends on the presence and settings of other elements. In certain scenarios, it was revealed that particular SEA elements were superfluous in the achievement of EI, as others compensated for them. For example, when the SEA authority examining and approving SEA reports was weak, or when Public Participation was poor, it was still possible to achieve optimum EI as long as other elements such as Impact Assessment, Decision-making and Review and establishment of Environmental Baseline were compensatory.

However, these compensatory scenarios were largely impractical, as they would occur only in long periods of SEA iteration (see Figures 7.10, 7.11 and 7.18), which cannot be guaranteed in practice. Moreover, in practical terms, the compensatory elements may overburden the procedures and there is no guarantee that they will indeed take up compensatory roles. Research approaches perceiving SEA as a comprehensive multi-dimensional system of dynamic feedbacks offers the possibility to overcome the handicaps of deconstructive approaches in studying the role of SEA in achieving EI. Deconstructing SEA into compartments runs the risk of failing to capture the complexity of interactions within SEA elements.

8.6 Weak correlation between SEA scores, SEA elements and EI

There was no evidence of strong or significant correlation between SEA element scores and SEA scores on the one hand, and EI scores on the other. Presence of SEA procedures, quality of procedures and quality of procedure output (PO) were significantly correlated to SEA quality, but not EI. This may in part be because the SEA procedure scores were used to calculate the SEA scores. The SEA procedure tally scores exhibited lower correlation with SEA scores than with the procedure quality scores. This confirmed that SEA is more than mere presence of procedures: quality and output of the procedures are more important. However, it is concluded that absence of correlation between SEA and EI does not exclude that other benefits of SEA did not occur, or that forms of EI measurable by other means did not occur. Commonly touted SEA procedures such as Public Participation, Scoping and Mitigation, on which SEA relies to achieve environmental protection, were generally lowly and insignificantly correlated to other SEA procedures, SEA scores or EI scores. When data was desegregated to sector levels, similarly, there was little evidence of correlation between SEA and EI. Nevertheless, correlation results clearly depicted sectoral differences inferring that within the context of this research, SEA and EI qualities were differentially achieved according to sectors.

8.7 Verification of assumptions held in the research

The two assumptions held in the research were tested and found not to be valid, as subsequently presented.

8.7.1 Higher SEA scores do not lead to higher EI scores

From the results of correlation between SEA and EI scores it emerged that there was no evidence to confirm the research assumption that higher SEA scores would correlate to higher EI scores. Similarly, when desegregated at sector levels, no evidence of such correlation emerged.

8.7.2 No specific cluster of SEA elements associated to achieving EI

From the questionnaire survey, it is concluded that UK SEA experts generally thought that SEA context elements were more effective in delivering EI than procedural. Similarly, from the cybernetic evaluation within the sensitivity analysis, it was clear that context elements were generally more effective in delivering EI, than procedural. Apart from this distinction based on categories of elements, evidence did not emerge that a certain cluster or core of SEA contextual or procedural elements were more conducive to delivering EI than others. Rather, it emerged that the context determined which and to what extent, an SEA element played a role in achieving EI. In conclusion, while UK SEA experts opinion revealed that SEA Scoping, independent Authority for Quality Control and Public Participation were effective in achieving EI, there was no significant evidence to support this belief based on correlation analysis and sensitivity analysis. Therefore, on balance of evidence, a cluster of specifically effective SEA elements was not identified; hence, the assumption was invalid. It was however revealed that depending on the starting parameters, any SEA elements may indeed be critical or relevant in achieving EI.

Chapter 9 Conclusions and Recommendations

This chapter aims to present the conclusions drawn from the findings of this research within the framework of the research questions. The research constraints, lessons learnt, overall conclusions, recommendations and suggestions for future research are subsequently presented. Finally, a summary of recommended specific tasks for future improvement of SEA's systematic delivery of EI and the enhancement of theory-building is provided.

9.1 Lessons learnt

This dissertation aimed at applying a quantitative approach to verifying claims in SEA definitions and the extent to which SEA and EI are amenable to quantitative evaluation. Several lessons have been learnt whilst fulfilling this aim and are subsequently presented.

Potential of quantitative research in enhancing theory-building in SEA

The indication of reliability and hence validity of results and findings was proof that quantitative research approaches hold significant promise in verifying hitherto acknowledged hypotheses and assumptions within SEA. Furthermore it can enhance theory-building through revelation of new knowledge e.g. through establishing associations and dynamics between SEA elements and EI, hitherto not revealed by qualitative approaches. Unlike qualitative type research approaches that were effective in description and theory generation, quantitative research provided the empirical basis for objective determination of association, cause-and-effect and theory-verification. In this way, quantitative research complimented hitherto qualitative empirical endeavours in SEA, and provided the empirical grounds for modifying hypotheses already generated within SEA. As argued at the start of the dissertation, quantitative research enhanced theory-building by providing the bases for transitioning from descriptive theory to normative theory. This l not only fulfilled conventional scientific theory-building and enhanced credibility of claims and hypotheses within SEA; but provided normative grounding for robust empirical explanations for SEA delivery of EI.

From the questionnaire survey, some tepid acknowledgement for the potential to enhance quality assurance through quantitative evaluation of both SEA and EI was revealed. This hinted at a realisation that UK SEA experts are recognising the potential of complementarity between qualitative and quantitative approaches, as their relative strengths can enhance validity when dealing with a complex process that cannot comprehensively be understood from one-dimensional approaches. In this context, quantitative approaches e.g. correlation analysis have proved capable in verifying association of SEA elements and EI, hitherto researched only through qualitative approaches. The results are an evidence-based empirical bases for re-assessing the predictions and quality assurances of SEA delivery of EI. Therefore, scientific principles i.e. empirically established set of facts, propositions, or principles useful especially in science, to explain EI phenomena within SEA, were established. Furthermore, if further research is to be conducted on SEA theory, then empirical evidence for re-evaluating and formulating future researches has been provided.

Triangulation enhances validity within complex phenomena

The approach of triangulation successfully enhanced the validity of findings within many methods that are otherwise inconclusive, if applied separately. This shed empirical insight from various methodical perspectives, in explaining and verifying a phenomenon. This is especially in areas where previous qualitative research approaches have offered neither empirically conclusive evidence nor generalization beyond peculiarities of the case study. Instead of relying on limited empirical input from correlation analysis, results of sensitivity analysis were also considered, as well as compared with those of questionnaire survey, where applicable. Triangulation facilitated the crosschecking and looking for further corroboration of evidence in order to draw more empirically valid conclusions. This had the effect of increasing the reliability and validity of interpreting research results in answering the research questions. Furthermore, from a practical perspective, such results may reduce over-investment in SEA elements that offer non-commensurate payload, having been selected based on empirical results from a single method, as a leverage to achieve EI.

It was also learnt that over-reliance on qualitative research approaches, with little complement from quantitative research, can lead to knowledge that while validly generated by one method, may in fact be incomprehensive and not adequately substantiated. Therefore, triangulation of results appropriately corroborated evidence from various methodologies, enhancing substantiation of inferences. Also, a systems-wide approach such as sensitivity analysis attempted to reduce errors suffered in understanding SEA systems and their complex phenomena i.e. false description of goals, one-dimensional analysis of situations, irreversible fore-grounding, neglected side-effects and over-steering, as stated in section 2.5. For example, case-study approaches had led to over-focus on Scoping, Public Participation and Consultation, as critical elements to deliver EI. While sensitivity analysis did not contradict the roles of such elements, it was evident that these elements were not singly critical in the larger picture when SEA is considered as a dynamic multi-dimensional systematic process.

Bounded SEA flexibility within sectors

From the sensitivity analysis and from the awareness that efficiency and effectiveness in leveraging SEA elements to attain higher EI is necessary, it was learned that a better understanding of the SEA system and its dynamics should precede any attempt to fine-tune the system. Identifying the most effective leverages in any SEA system based on prevailing conditions, is critical. Since correlation analysis revealed that sector-level patterns of association exist; and since flexibility within SEA was occasionally used to avoid rigorous SEA; it appears that sensitivity analysis at the sector level can be an appropriate departure point for constricting SEA flexibility, while establishing the detailed leverages necessary to achieve EI. This means that while flexibility within case by case natures is encouraged, the revealed sector-level system dynamics within which EI is achieved must be recognised and adhered to. For example if Scoping within the transport sector is significantly correlated to SEA or EI score, then quality assurance must ensure this association is maintained in Transport sector SEAs. The same idea of sector specifics can be applied within the regional or national contexts, as opposed to case-by-case basis, *per se*. This tension between the need to apply case-by-case flexibility and that of complying within sector-specific boundaries, as revealed by sensitivity analysis, may contribute to addressing the current misuse of the ‘flexibility within SEA’. Therefore, SEA flexibility ceases to be a blank check for avoiding rigorous SEA and EI quality.

Combining qualitative and quantitative approaches

Within SEA, this research has demonstrated how qualitative and quantitative methods can be combined to complete key stages in theory-building. While the research approach was quantitative, in practice, the evaluation of SEA and EI was quasi-quantitative because the criteria were first assessed qualitatively then given quantitative (numerical) values. Also, while objectives and indicators are objective and based on knowledge, their evaluation was subjective and based on individual judgment. Therefore, the assessment and evaluation of statements of environmental objectives and indicators were instances of quasi-quantitative evaluation, in which some subjectivity may pass on to the quantitative aspects. However, the provision of explicit criteria for evaluation made the process more transparent. The attainment of reliable data, as demonstrated in section 6.5 of this thesis, inductively led to the conclusion that the combination of both qualitative and quantitative approaches can be applied in SEA research, with valid results.

Potential of cybernetic analysis in understanding and managing SEA complexity

Finally, the insight into the systematic nature of SEA has revealed that use of scenario techniques and simulations enhanced the understanding of the dynamics within complex SEA processes. This portends invaluable potential to advance SEA theory-building, as sensitivity analysis has the ability to simplify and offer explanations for complexities in SEA delivery of EI. Furthermore, an efficient and effective consideration and coordination of inputs from different system actors or parameters can thereafter be made, which provides for evidence-based communication and methodological framework within which EI can be achieved, implemented and monitored. Therefore, as opposed to priority being given to Scoping, within the UK context, similar and no less attention be simultaneously given to other SEA elements now revealed to be equally significant in delivering EI. The cybernetic evaluation offered deeper insight by treating all the elements relative to each other within one system, revealing their interactions and relative effectiveness in achieving EI. This has rarely been done in SEA research and is an opportunity to reduce the one-dimensional approach to understanding complex phenomena. Deeper and more comprehensive understanding of SEA has provided empirical bases for further theory-building and development in SEA, as explanatory and causative elements become better established.

9.2 Constraints

Several constraints were identified in applying the methodological approach used in the study, and are subsequently discussed.

Access to SEA reports

Since the SEA reports used in this research were found on the Internet, the validity of generalized conclusions that can be derived from the research data may be constrained in case not all quality of SEA reports had the same probability of being put on the Internet. In some cases, third editions of revised SEA reports were found on the Internet, while the earlier versions were no longer available. This means that SEA reports of some category of quality did not have equal probability of availability on the Internet. The sample of SEA reports studied were dated between May 2002 and February 2008, and only represents SEAs done following guidelines of the EC SEA Directive. Those done before the SEA Directive took effect were voluntarily done following the SEA Directive. It was therefore not clear to what degree the force of legal regulation was effective.

The choice of the SEA reports used in this research was extensively influenced by practical considerations, particularly the accessibility of the cases. This constraint influenced the types of conclusions that can be derived from the research data, and the analysis thus focuses more on theoretical, rather than statistical, inferences. This implies that results from such samples will enhance the understanding of theoretical phenomena, but without the full scale of results from practice being captured, because not ALL samples from practice had the same probability of being accessed. Nevertheless, such a constraint was deemed to have little influence in answering the research questions, and consequently, did not have significant effect on the reliability and accuracy of results.

Country and sector differences

Although all SEA samples were done under the same SEA Directive and UK Regulations, the extent to which the diversity of contexts in which SEA operates within Scotland, Wales and England may have undermined the concept of procedural universality and influenced EI and SEA results, if at all, was not known. SEA procedures in Scotland are for example more stringent than those in England. Furthermore, various sectors suffer different environmental impacts and to various severities. Moreover, some sectors offered more environmental objectives than others e.g. wind energy over the North Sea had relatively fewer environmental issues than a waste plan. Therefore, the quantitative evaluations of procedures and procedure-output quality could indeed be different as a reflection of sectoral context and not as factor of SEA quality. However, the potential of this constraint to undermine validity of results was deemed almost negligible because the SEA and EI frameworks were generally similar and the question of correlation between SEA and EI can be answered regardless of the procedural and contextual specifics.

Complex nature of EI

From a conceptual perspective, the notion that EI is achieved mainly through the ‘transformational learning’ component of SEA processes may imply that the EI results from the reports may be incomplete or inconclusive. This may be so in case the long-term incremental effects of EI could better show the achievement of SEA, rather than the EI immediately reflected in the SEA reports. While this learning component is stated to require "long times" to be evident as a result of decision-making processes, it is not clear what is a "long time". This ambiguity in the timeframe is aggravated in case "long time" means several years of SEA practice, as opposed to several iterations within the SEA process. Nevertheless, this constraint was ruled inconsequent because SEA has almost a two-decade history of practice in the UK, albeit under the SEA Directive only since 2004. More fundamentally, the research limited its definitional scope of EI to the immediate results of decision-making i.e. environmental objectives and indicators as immediately indicated in the SEA reports.

Individual versus group evaluation

Finally, the validity in the assessment and quantitative evaluation of SEA and EI, though enhanced by providing a simple and explicit criteria, could have been more reliable had the evaluation been done by a group, as opposed to the individual researcher. Statistically, an individual has a higher likelihood of bias, though systematically, than a larger number of evaluators. In this context, the group has a higher probability to approximate towards less bias in their evaluation scores than the individual. Less bias would lead to more accurate and reliable results.

Different qualities and non-homogeneity of SEA reports

The SEA reports and the environmental statements were not uniformly presented. Therefore, a significant constraint came from the inconsistent formats of presentation of SEA reports, with levels of details widely varying from comprehensive and elaborate presentations to tables, matrices and graphs. For example, the scope and level of detail were not the same; the formats, while at least including all requirements of the SEA Directive, were not the same. In some cases the narrative of events and detail was not concise, leading to some incomplete informations. In some reports, the details of procedures are skipped and only outputs reported. This made it difficult to ascertain what type of SEA procedure was undertaken, or whether it was at all carried out. Some reports contained unsubstantiated statements without clarification or supporting background material. In some cases the language was imprecise and the technical content inadequate. For example, statements of objectives and indicators often did not comprehensively follow the SMART convention, thus obfuscating carelessness in report writing with inadequate attention to EI. In some cases the statements of objectives were too general to convey any specific meaning, although it was obvious that not everything was intended to be done. While direction of change was often indicated, the targets often did not specify the expected degree of change. Also, targets were often poorly defined, and mostly in qualitative terms only. For example, a PP's environmental objective statement such as "lowering carbon emissions according to the national standards" was practically meaningless, because the national target was not to be achieved by the PP, but by cumulative PPPs. Furthermore, no quantification of the "lowering" was provided, in many cases.

Rigidity of reporting format

The SEA reporting format while binding and regulated by law, could have contributed in obscuring the true extent of EI, as every SEA report attempted to meet required environmental objectives in order to comply with the law. This made every SEA report have an environmental objective on all environmental themes found in the SEA regulations, even when in reality, there was very limited scope for a meaningful environmental objective within the sector-specific framework of the PP. This hampered evaluative assessments and made distinction rather cumbersome, among genuine objectives and those merely inserted for regulatory compliance.

Uncertainties from questionnaire results

While the response rate from the questionnaire was significant, it is not certain how the low number of respondents compared to the effective number needed in such a questionnaire exercise. The reasons why a number of potential respondents did not answer the questionnaires remain unknown; and it is equally unknown what responses would have come from this group. Therefore, this introduces some uncertainty on the validity of the representativeness of the sample. From the questionnaire design, the multiple choice options may have limited the potential pool of responses and thereby restricted respondent's flexibilities in expressing themselves. Nevertheless, this handicap was considered low as a dry-run of the questionnaires had been undertaken and relevant suggestions incorporated. Therefore, the limitations and potential misunderstandings due to the questionnaires was considered reduced as not to compromise the validity of results.

9.3 Overall conclusion

The thesis fulfilled its research aim of verifying the validity of the claims commonly accepted in the SEA definitions by applying quantitative methods. It has verified the SEA definitional claims stating that 1) SEA achieves EI in PPs, and that 2) SEA is a systematic process with negative and positive feedback loops that trigger self-correction. In the process, the extent SEA and EI are amenable to quantitative evaluation; and the extent SEA behaves systematically, have been determined. The conclusions of the quantitative research approach in this research have demonstrated that hypotheses and claims with SEA can be empirically verified, hence facilitating deductive analyses and confirmation of such claims. Hence, theory generation is complimented by theory-verification, a significant component in classical scientific research that entails a hypothetico-deductive paradigm. SEA theory-building is therefore enhanced by providing empirically derived information on SEA. Hitherto held assumptions and claims have been empirically verified and newer understandings of association within SEA elements revealed. The findings of the research have significantly contributed to suggestion that in order to understand and critique SEA, attention must be given to the nature and context of the SEA system and PP influence. Equally important, is the context and objectives of SEA application and the SEA process itself. The role for quantitative approaches in enhancing theory-building in SEA has been established in this dissertation although this potential for unpacking complexities in SEA is yet to be fully exploited. This research has demonstrated that it is possible to apply quantitative research approaches in evaluating the quality of SEA procedures and their outputs, and EI in PPPs, based on outputs of decision-making in terms of statements of environmental objectives and indicators. The data generated proved reliable and the analysis derived from them was found to be empirically sound based on triangulation of results with other methods.

Drawing on the evidences considered, it was concluded that there was no significant statistical evidence to confirm the claim that SEA achieved EI in UK PPs, as defined in this thesis; nor was their any evidence to confirm the assumption that a specific cluster of SEA elements was more correlated to EI achievement. Furthermore, based on the research sample, it has been confirmed that SEA behaved as a poor system in terms of having negative and positive feedbacks; it is stubbornly stable and prone to over-developing even when self-correction was necessary. The resultant data from this study should at this stage be understood as indicative and relative, and not as absolute quantities of SEA and EI. Based on the need to further unpack and understand SEA complexity and dynamic behaviour in achieving EI, and; consequently enhancing SEA knowledge, practice and quality, efforts to pursue quantitative methods in SEA should continue.

9.4 Recommendations

While the successful applicability of quantitative research approaches to SEA and EI has been demonstrated, there remains room for improved and more robust application of quantitative research methods. Several recommendations are made within the framework of this research, as subsequently mentioned.

Tiering between Sector- and PPP -specific sensitivity analysis

This study determined the extent SEA was systematic and revealed that specific conditions present particular dynamics between the SEA elements. While it was concluded that context and parameter of elements mattered, it is recommended that future simulations (sensitivity analysis) and application of quantitative evaluation methods be focused at sector levels e.g. energy, agriculture, trade or at thematic levels e.g. spatial land use plan, or spatial policies. Moreover, the methods of OSPA and sensitivity analysis should be applied at more specific levels e.g. single sectors, as opposed to mixing several sectors within one study. For OSPA, the reference environmental objectives and indicators can be more specific and therefore more conducive for evaluation; for sensitivity analysis, the specifics of a more specific situation will reveal more useful information than a more generalised one, as would happen if SEAs from several sectors are analysed together. This is an appropriate level because an evaluative framework and criteria can be applied that is more concrete and closest to the sector-context, as opposed to SEA Directive-wide range of criteria which in some cases is superfluous to the context. The SMRT criteria, at sector level, can be more pinpointed to sector scale and specifics, as opposed to SMRT criteria for SEA Directive-wide generality. While the findings from sensitivity analysis supports the mantra that SEA needs to be context-specific, sector level sensitivity analysis will reveal relevant SEA elements for leverage, at this level, as it has been proven in this thesis that consistent patterns of associations exist at sector level. This will reveal sector level relevant SEA elements for leverage, at specific sectors, recognising relevant initial SEA system parameters critical in determining how the system develops and the potential of influencing the system to achieve EI. Once sensitivity analysis has revealed the dynamics and boundaries that achieve the desired EI, then the practice of SEA within that sector or theme can be flexibly applied within those boundaries. This has the potential of disciplining SEA application and reducing the abuse of its flexibility.

Calibration and standardisation

With a successful quantification system, evaluation of SEA and EI should be calibrated so that standard quality measurements can be established within sectors, regions, themes or countries. This can enhance quality assurance and differentiation of competing SEA reports or PPs, say for funding. Furthermore, when standards are known, then SEA and EI qualities can be gauged more objectively. A simple calibration can be achievable by identifying representative “highest” and “lowest” SEA and EI scores, and then creating relevant calibration units that are accordingly spread across the spectrum.

Short and efficient feedback loops

Having demonstrated the need to establish more negative feedback loops to make the SEA system more dynamic, focus should be on the mechanisms for integrating *more* and *efficient* negative feedback loops. The aim is to achieve correct regulatory trigger within shortest period through effective and efficient mechanism. In this context, elements such as Quality Control, PPP options evaluation and Monitoring and Evaluation were identified as potential first-choice candidates, based on the results of cybernetic evaluation and simulation. There is need to create holding points for quality review within the SEA system, from which iterative feedback loops can assert more negative effects to avoid over-development. For example, the Environmental objectives setting stage can be guided with a certain quantitative standard during the formulation of environmental objectives. The SEA practitioner can ensure that this guidance is observed; and furthermore, the approving authority of the SEA report can audit, ensure and enforce that a set standard of environmental objectives is met. In this recommendation, it is envisaged that the procedure to establish environmental objectives is repeated until a desired quality is achieved. It would be better to create several quality holding points or pit stops, where many intermediate stages offer short and swift reactions for Quality Control. Other examples of holding points are the Mitigation stages, Monitoring and Evaluation, and indicator setting stages. Guidances for meeting certain quantitative thresholds should be provided, and SEA approving authorities can audit and ensure compliance. Moreover, many intermediate steps will introduce more degrees of interconnectedness, a basic cybernetic indication of a viable system.

9.5 Scope for further research

Six ideas are subsequently presented for future research within the context of the research framework set out in this dissertation.

A larger evaluation of PP from different EU countries

Since the UK is arguably not the best example for EI within the context of the SEA Directive, verifying the research results can be enhanced by using a larger sample of SEA cases, especially from other EU countries known to have better EI. While the applicability of quantitative research approaches to SEA and EI has been demonstrated, there remains room for improved and more robust application of quantitative research methods. This should in future involve the use of larger samples as they will provide more reliable results. Therefore, SEA reports spread over longer periods should be used, particularly to also cover SEAs done under SEA Directive in other EU countries more reputable for better SEA-led EI than the UK. This is because the UK is not ‘the best’ example for such a research in the EU, as it does not have a very ‘green’ political history. In the UK, urban and transport planning are dominant sectors and landscape planning does not exist unlike in Germany. Furthermore, economic issues have been reported to significantly outweigh environmental ones. Therefore, a larger sample comparing results from more EU countries will provide a more comprehensive data set than produced in this research, leading to enhanced reliability of results.

Reduction of Type II errors

While hypothesis testing based on significance levels ideally deals with reduction of Type I[41] errors, it is recommended that further research focuses on efforts to reduce Type II errors within the research designs. This will avoid accepting the null hypothesis because of greater data variability preventing statistical technique from showing a significant difference, or data not being precise enough to show up the subtle changes. This is because data variability was significant in certain data sets, and the extent to which they distorted results is not known. In this context, in regard to future research designs, efforts to reduce Type II errors within the design must be made. This will avoid accepting the null hypothesis because greater data variability prevented statistical techniques from showing a significant difference; or because data was not precise enough to show up the subtle changes.

Double blind testing

Having concluded that quantitative evaluation of SEA and EI is possible, it would enhance validity of this conclusion if SEAs known to be of high and low SEA and EI, are subjected to double blind tests. The aim is to create relatively more objective, potentially repeatable and unbiased testing environments, in future studies. To ensure the results are accurate and will stand up to analysis by other members of the scientific community, a double blind test will include SEA and EI reports of known low and high scores, and subject them to quantitative

[41] In statistics Type I (false positive) and Type II errors (false negative) refer to possible mistakes made in a statistical decision process. Type I error occurs when the null hypothesis is wrongly rejected while it is true. A Type II error occurs when the null hypothesis is accepted when it should in fact be rejected.

evaluation. This can further verify the feasibility of OSPA and confirm its methodological ability to calibrate and differentiate EI achieved in SEA reports.

Cost Benefit Analysis for fine-tuning of SEA systems

Having demonstrated the need to establish more negative feedback loops to make the SEA system more self-regulating towards a particular EI range, research to identify most cost-effective feedback connections should be carried out. Focus should be on identifying and integrating more negative feedback loops in order achieve regulatory trigger within shortest period, effectively and efficiently. Since it is clear that within a system SEA elements will have varying roles and effects, future research should focus on allocating resources into SEA elements that guarantee the most effect (benefits) at least cost.

Significance and critical test level

Although establishing the correlation between SEA and EI is itself significant in advancing SEA theory-building by unpacking the complex interrelations within SEA, causality between the elements would have to be further investigated. This research has relied on demonstrated association based on critical tests at 95% and 99% confidence levels set within the computer software for data analysis. However, there is no reason to assume that these numbers correlate to causal significance in the practical UK SEA environment. The possibility of significant correlation at other confidence levels and critical tests levels cannot be ruled out. Therefore, selecting critical test levels for hypotheses testing ought to be empirically explored, for use in future similar researches.

Analyzing questionnaire response rates and non-response bias

There is need to determine what the empirically expected mean response rate is within the questionnaire tool in SEA, as applied in similar circumstances. Therefore, the adjusted response rate of 25% in this research can be compared against a normative rate in order to ascertain validity of results. Furthermore, non-response bias, the possibility that non-respondents held views different from the study sample, needs to be determined. Conducting follow-up survey on the sample of non-respondents can do this.

More quantitative methods

Since this research has proved SEA correlation to EI using correlation analysis; and aware that association does not mean causation, research should expand triangulation methods by adding Factor Analysis or Principal Component Analysis (PCA). The aim is to distinguish by relative weight the contribution per SEA element to achievement of EI. This will determine the SEA elements that account for much of the variability in the SEA and EI data. Factor analysis is a statistical method used to describe variability among observed variables in terms of fewer unobserved variables called factors. Factor analysis can reveal which variables among many provide what effect within the behaviour of SEA system, and in delivering EI. Principal Component Analysis, a variant of factor analysis, can be also applied to account for the variability in the data. It has the advantage that both objective and subjective attributes can be used; hidden dimensions or constructs which may or may not be apparent from direct analysis can be identified; it is not extremely difficult to do, and; it is inexpensive and accurate. This can further enhance unpacking of understanding SEA processes, thereby further contributing to theory-building.

9.6 SEA outlook –challenges and future steps in enhancing theory-building

In order for SEA to overcome the hurdle of unsubstantiated claims, enhance theory-building and establish scientific knowledge based on conventional empirical paradigms, SEA research is potentially faced with two key challenges. One, how to communicate and ensure that scientific knowledge within SEA experts is harmonised and the gap between substantiated and unsubstantiated knowledge is reduced. Secondly, engaging SEA proponents, researchers, practitioners and administrators in collaborative research to identify the various challenges for each group in differentiating and ascertaining quality in SEA and EI, may not be easy. The results of correlation and questionnaire survey revealed that these various SEA experts held different understandings of the terms environment, EI and on effectiveness of SEA. Furthermore, as was revealed in Chapter 5, they have various levels and sources of knowledge of SEA efficacy. Ultimately, the SEA researchers have to integrate the various concerns in generating research designs for addressing the above challenges.

In this context, in addition to one-dimensional themes of investigation, comprehensive approaches through systems analysis be encouraged to investigate more realistic leverages that will cost-effectively deliver EI. However, those on SEA periphery, SEA administrators and practitioners must be involved in identifying challenges for them in differentiating SEAs and EI at various qualities. They must also participate in identifying how scientific research can advance their knowledge base and practice in SEA, in terms of systematic delivery of EI. Researchers have to integrate these concerns into generating more quantitative and objective frameworks for quality differentiation. Within this context, standards and thresholds be established, more desirably, for sector and thematic levels. OSPA-like frameworks stand a more realistic chance for quality differentiation, and should be further tested and refined, as a basis for standards, thresholds and quality control.

In terms of enhancing SEA systematic delivery of EI, researchers, academics, practitioners and administrators need to collectively focus on key areas[42] of quality evaluation and enhancement through more negative and positive feedback loops. These hold points should be stages of SEA e.g. Monitoring and Evaluation of SEA Follow-up; establishing of environmental objectives and indicators. During Follow-up, "Good Practice" procedures should be benchmarked and quantitatively translated, so that quality criteria can be applied, and results used to trigger feedback (integration) into iterative procedures and/or other relevant stages for quality review. A key challenge in introducing more feedback loops is the need to avoid introducing new procedures that practitioners and administrators may find cumbersome. The key criteria in selecting these hold up points are:

1) Choosing established stages of SEA quality consideration e.g. SEA Monitoring and Evaluation and/or SEA Follow-up;
2) Identify stages conducive to application of quantitative evaluation frameworks e.g. evaluation of environmental objectives and indicators;
3) Select stages of considerable drive and/effect within the system e.g. the background elements identified by sensitivity analysis, as candidates for quality hold points. This is because these elements have great influence and may therefore significantly determine EI;
4) Consider the numbers of feedback links e.g. several and short feedback loops are better than fewer and longer feedback loops that tend to take too long to take corrective effects.

In conlcuison, a summary of recommended specific tasks for future improvement of SEA's systematic delivery of EI and the enhancement of theory-building is provided in Box 11.

[42] These areas are within SEA stages and/procedures as well as Environmental Integration mechanisms, methods or procedures.

Box 11: Recommended tasks for enhancing systematic delivery of EI and theory-building		
Recommended tasks	**Where/when**	**By whom**
Identify quality hold points where more negative and positive feedback mechanisms can be introduced	At key SEA stages or procedures e.g. establishment of environmental objectives; identification of strategic options; mitigation plans; monitoring and evaluation and feedback loops into iterative steps	Researchers to apply sensitivity analysis and other models to identify critical areas of feedback links;
Identify mechanisms for most effective and efficient feedback links	Between procedures and key stages	SEA Researchers, practitioners and administrators
Set standards and thresholds, preferably quantitative ones	For use in evaluating quality at key hold points	Researchers and administrators
Establish sector environmental objectives and indicators to enhance OSPA application	Sector level	Researchers, practitioners and administrators
Refine quantitative evaluation methods	SEA evaluation and OSPA application	Researchers relying on contribution form administrators and practitioners
More quantitative methods e.g. Factor Analysis and Principal Component Analysis	During research to determine contribution of SEA elements towards EI achievement.	Researchers
Cost Benefit Analysis	Before new procedures are added to current SEA system	Researchers, practitioners

Annex 1: SEA Environmental report requirements as listed in Annex 1 of SEA Directive (EC 2001)

(a) an outline of the contents, main objectives of the plan or programme and relationship with other relevant plans and programmes; (b) the relevant aspects of the current state of the environment and the likely evolution thereof without implementation of the plan or programme; (c) the environmental characteristics of areas likely to be significantly affected; (d) any existing environmental problems which are relevant to the plan or programme including, in particular, those relating to any areas of a particular environmental importance, such as areas designated pursuant to Directives79/409/EEC and 92/43/EEC; Section 4.4, 7.5; (e) the environmental protection objectives, established at international, Community or Member State level, which are relevant to the plan or programme and the way those objectives and any environmental considerations have been taken into account during its preparation; (f) the likely significant effects on the environment, including on issues such as biodiversity, population, human health, fauna, flora, soil, water, air, climatic factors, material assets, cultural heritage including architectural and archaeological heritage, landscape and the interrelationship between the above factors; (g) the measures envisaged to prevent, reduce and as fully as possible offset any significant adverse effects on the environment of implementing the plan; (h) an outline of the reasons for selecting the alternatives dealt with and a description of how the assessment was undertaken including any difficulties (such as technical deficiencies or lack of know-how) encountered in compiling the required information; (i) a description of the measures envisaged concerning monitoring in accordance with Art. 10. (j) a non-technical summary of the information provided under the above headings.

Annex 2: SEA report as required by the Regulations (source: adopted from ODPM 2005)

Structure of report	**Information to include**
Non-technical summary	• Summary of the SEA process • Summary of the likely significant effects of the plan or programme • Statement on the difference the process has made to-date • How to comment on the report
Methodology used	• Approach adopted in the SEA • Who was consulted, and when • Difficulties encountered in compiling information or carrying out the assessment
Background	• Purpose of the SEA • Objectives of the plan or programme
SEA objectives and baseline	• Links to other international, national, regional and local PPs, & relevant environmental objectives • Description of baseline characteristics and predicted future baseline • Environmental issues and problems • Limitations of the data, assumptions made etc. • SEA objectives, targets and indicators
Plan/Programme	• Main strategic alternatives considered and how they were identified

issues and alternatives	• Comparison of the significant environmental effects of the alternatives • How environmental issues were considered in choosing the preferred strategic alternatives • Other alternatives considered and why they were rejected • Any proposed mitigation measures
Plan or programme policies	• Significant environmental effects of the policies and proposals • How environmental problems were considered in developing the policies and proposals • Proposed mitigation measures, uncertainties and risks
Implementation	• Links to other tiers of PPs and the project level EIA, design guidance etc.) • Proposals for monitoring

Annex 3: SEA stages and procedures constituting the SEA process, according to the guidelines for carrying out an SEA (ODPM 2005)

SEA Stage A. Setting the context & objectives, establishing the baseline & deciding on the SEA scope	
A1: Identifying other relevant PPPs & environmental protection objectives	To establish how proposed PPP is affected by outside factors, to suggest ideas for how any constraints can be addressed, and to highlight contradictions and synergies
A2: Collecting baseline information	To provide an evidence base for environmental problems, prediction of effects, and monitoring; to help in the development of SEA objectives and indicators.
A3: Identifying environmental problems	To help focus the SEA; streamline subsequent stages, including baseline information analysis; setting of the SEA objectives, prediction of effects and monitoring.
A4: Developing SEA objectives	To provide a means by which the environmental performance of the PPP and alternatives can be assessed.
A5: Consulting on the scope of SEA	To ensure that the SEA covers the likely significant environmental effects of the PPP.
Stage B. Developing and refining PPP alternatives and assessing effects	
B1: Testing the PPP objectives against the SEA objectives	To identify potential synergies or inconsistencies between the objectives of the PPP and the SEA objectives and help in developing alternatives.
B2: Developing strategic alternatives	To develop and refine strategic alternatives.
B3: Predicting the effects of the RDP, including alternatives	To predict the significant environmental effects of the draft PPP and alternatives.

B4: Evaluating the effects of the PPP, including alternatives	To evaluate the predicted effects of the PPP and its alternatives and assist in the refinement of the draft PPP.
B5: Mitigating adverse effects	To ensure that adverse effects are identified and potential mitigation measures are considered
B6: Proposing measures to monitor the environmental effects of the RDP implementation	To detail the means by which the environmental performance of the draft PPP can be assessed.
Stage C. Preparing the Environmental Report	
C1: Preparing the Environmental Report	To present the predicted environmental effects of the draft PPP, including alternatives, in a form suitable for public consultation and use by decision-makers.
Stage D. Consulting on the draft PPP and the Environmental Report	
D1: Consulting the public and Consultation Bodies on the draft PPP and the Environmental Report	To give the public and the Consultation Bodies an opportunity to express their opinion on the findings in the Environmental Report and to use it as a reference point in commenting on the draft PPP. To gather more information through the opinions and concerns of the public.
D2: Assessing significant changes	To ensure that the environmental implications of any significant changes to the draft PPP at this stage are assessed and taken into account.
D3: Making decision and providing information	To provide information on how the Environmental Report and consultees' opinions were taken into account in deciding the final form or the PPP to be adopted.
Stage E. Monitoring the significant effects of implementing the RDP on the environment	
E1: Developing aims and methods for monitoring	To track the environmental effects of the draft RDP to show whether they are as predicted; to help identify adverse effects.
E2: Responding to adverse effects	To prepare for appropriate responses where adverse effects are identified.

Annex 4: List of PPs and SEA reports used in the quantitative Evaluation of SEA and EI

Reference number and name of document		**Date of report**	**Sector**	**Remarks**
S1	Integrated SA for Planning Southampton to 2026 – Local Development Framework Core Strategy	Oct 2006	Development Plan	Spatial
S2	Pilot SEA for the proposed replacement Midlands Waste Management Plan 2005 – 2010	Jul 2005	Waste	Voluntary SEA
S3	SEA of Greater Manchester's Local Transport Plan2	May 2006	Transport	Spatial
S4	SA report of the Draft North West Regional Spatial Strategy	Jan 2006	Development Plan	Regional Plan-Spatial
S5	SA/SEA of South Hams Core Strategy (submission document)	Jan 2006	Development Plan	Spatial
S6	Strood Riverside SA Final Draft Supplementary Planning Document	May 2006	Development Plan	Spatial
S7	West Midlands Local Transport Plan 2006 – 2011, SEA statement	Jul 2006	Transport	Voluntary Spatial
S8	SEA of the Former White Zone (Volume 1 – 3), consultation document	Aug 2000	Offshore licensing	Voluntary
S9	SEA of the Mature Areas of the Offshore North Sea - SEA 2	Sep 2001	Offshore licensing	Voluntary
S10	SEA of Parts of the Central & Southern North Sea - SEA 3	Jan 2003	Offshore licensing	Voluntary
S11	Offshore Wind Energy Generation: Phase 1 Proposals and Environmental Report (SEA report)	Apr 2003	Wind	Voluntary
S12	SA Report, Blackburn with Darwen Borough Council's Local Transport Plan2	2006	Transport	Spatial
S13	Cheshire Waste Local Plan SA of the First Deposit Draft Plan Final Report	Oct 2004	Waste	Voluntary
S14	Cheshire Replacement Waste Local Plan, SEA Environmental Report	Oct 2005	Waste	Spatial
S15	SEA of the ERDF Operational Programme for the North West 2007-2013	Dec 2006	Structural Funds	Spatial

Reference number and name of document		Date of report	Sector	Remarks
S16	Cheshire County Council Local Transport Plan2 SEA	Jul 2006	Transport	Spatial
S17	Warrington Borough Council Local Transport Plan, SEA Environmental Report	Feb 2006	Transport	Spatial
S18	Milton Keynes Local Transport Plan 2006/7 to 2010/11 SEA Statement Report	May 2006	Transport	Spatial
S19	Local Transport Plan for Merseyside, SEA and HIA Scoping report	Jul 2005	Transport	Spatial
S20	Bedfordshire County council and Luton Borough Minerals Development Framework SA	Nov 2005	Minerals	Spatial
S21	Bury LDF Core Strategy –Sustainability Appraisal	Jul 2007	Development Plan	Spatial
S22	Tameside Metropolitan Borough Council SA of LDF Core Strategy and Hattersley AAP	Jun 2006	Development Plan	Spatial
S23	Sustainability Appraisal and SEA of North Hertfordshire LDF	Aug 2005	Development Plan	Spatial
S24	West Cheshire and North East Wales, sub-Regional Spatial Strategy, SA report	Nov 2005	Development Plan	Regional Spatial
S25	HoV (Heads of the Valleys) Regeneration Strategy, Draft SEA/SA Report	Oct 2006	Development Plan	Spatial, Wales
S26	SEA of Wales Rural Development Plan	May 2006	Development Plan	Spatial, Wales
S27	Powys County Council Unitary Development Plan Draft SEA Environmental Report	Jul 2005	Development Plan	Spatial, Wales
S28	City and County of Swansea, SEA and SA of The Deposit Draft Unitary Development Plan	Oct 2005	Development Plan	Spatial, Wales
S29	Wales Freight Strategy SEA	Nov 2006	Transport	Spatial, Wales
S30	Wales Transport Strategy	Oct 2006	Transport	Spatial
S31	Wrexham Local Development Plan	Aug 2006	Development Plan	Spatial, Wales

Reference number and name of document		Date of report	Sector	Remarks
S32	SEA of the Neath Port Talbot Unitary Development Plan	Mar 2005	Development Plan	Spatial, Wales
S33	Wales ERDF convergence programme	Aug 2006	Structural Funds	Spatial
S34	Flintshire Unitary Development Plan, SA and SEA	Oct 2006	Development Plan	Spatial, Wales
S35	Humber Estuary Flood Defence Strategy SEA Environmental Report	Jun 2005	Flood Strategy	Infrastructure Management Strategy
S36	Ashford Borough Council – town centre area action plan (LDF)	Apr 2006	Development Plan	Spatial, Wales
S37	Greater London Authority, SA	Apr 2004	Development Plan	Spatial, Voluntary
S38	South Oxforsdhire SA of Local Development Framework	2006	Development Plan	Spatial
S39	Turnbridge Wells Borough, Local Development Framework	Dec 2005	Development Plan	Spatial
S40	West Wales and the Valleys ERDF	Mar 2007	Structural Funds	Spatial
S41	Aberdeen Housing Strategy, Environmental Report	2006	Housing	Spatial, Scotland
S42	Cornwall County Council Local Transport Plan2 SEA Environmental Report	Dec 2005	Transport	Spatial
S43	Suffolk Minerals Core Strategy	Oct 2007	Minerals	Spatial
S44	SA/SEA of Wiltshire & Swindon Waste Core Strategy	Feb 2008	Waste	Spatial
S45	Wiltshire and Swindon Minerals Core strategy SA for the Draft Submission Document	Feb 2008	Minerals	Spatial
S46	West midlands ERDF	Apr 2007	Structural Funds	Spatial
S47	Kilburn Supplementary Planning Document Sustainability Appraisal Report	Feb 2005	Development Plan	Spatial

Reference number and name of document		Date of report	Sector	Remarks
S48	Aberdeen Local transport Strategy 2006-2009 Environmental Report	Feb 2006	Transport	Spatial, Voluntary
S49	Identifying Areas of Search for Regional Waste Facilities Across Wales. Project Report	Jul 2007	Waste	Spatial, Wales
S50	SA for North East Regional Spatial Strategy	Feb 2008	Development Plan	Spatial, Regional Plan
S51	SA Of Rochdale Unitary Development Plan	May 2002	Development Plan	Spatial
S52	Background paper: SA of the Consultative Draft Angus Local Plan 2003	Dec 2003	Development Plan	Spatial, Voluntary
S53	SA report on the Draft South East Plan	Mar 2006	Development Plan	Spatial
S54	SA of Local Development Documents of the Teignbridge LDF2001-2016	Oct 2006	Development Plan	Spatial

Annex 5: Glossary of technical terms and types of Development Planning Documents (DPDs) whose SEAs were used in the study:

Area Action Plans – blueprint that sets out the spatial strategy for the regeneration of the town centre.

Core Strategy – plan blueprint setting out overall long-term vision for land use in the borough. Includes strategic objectives, a spatial strategy, core policies and broad locations for development. All other policies will hinge off the Core Strategy.

Development Plan Documents (DPDs) – documents included in the Local Development Framework (LDF) e.g. Core Strategy, Site Specific Allocations, Area Action Plans, proposals maps etc.

Local Development Documents (LDDs) - these present the policies of the LDF. Both DPDs and SPDs can be classified as being LDDs.

Local Development Framework (LDF) - the collective name for the new plan that superseded the Unitary Development Plan (UDP) from the old planning framework. Planning application is determined with regard to the new LDF, alongside the RSS. The LDF provides the framework for delivering the RSS for the area and will contain core strategy, site-specific allocations of land; area action plans (where necessary); and proposals map (where necessary)

Local Transport Plan (LTP) - produced by the county council or unitary council and sets out the transport strategy for the county.

Planning Policy Statements/Guidance (PPS/Gs) - a series of notes setting out the government's policies on various topics, e.g. housing, transport, etc.

Regional Spatial Strategies (RSS) - prepared by the regional planning body, e.g. Development Agency; sets out policies in relation to the development and use of land. RSS provides a spatial framework to inform the preparation of LDDs, Local Transport Plans (LTPs) and regional and sub-regional strategies and programmes that have a bearing on land use activities.

Supplementary Planning Documents (SPDs) - advisory documents that build upon policies in the LDF and taken into consideration when planning applications are being determined.

Sustainability Appraisals (SAs) - sustainability assessment of the economic, social and environmental impact of policies, and will accompany each part of the new plan.

Scoping Report - describes the methodology and scope of the sustainability appraisal work to be conducted and collates information on relevant PPs and baseline information.

Unitary Development Plan (UDP) - adopted in 1997 and replaced by the LDF under the Planning and Compulsory Purchase Act 2004. UDPs give effect to over-arching goals of Sustainable Development; Building a dynamical advanced economy; Tackling social disadvantages; and Equal opportunities.

European regional development fund (ERDF) - aims to strengthen economic and social cohesion in the European Union by correcting imbalances between its regions. It finances job creation, infrastructures linked to research and innovation, telecommunications, environment, energy and transport, and other financial instruments and technical assistance measures http://ec.europa.eu/regional_policy/funds/feder/index_en.htm

Annex 6: Questionnaire survey

Department of Environmental Planning
Brandenburg University of Technology, Cottbus, Germany
26th June, 2007

RE: Questionnaire survey
My name is Vincent Onyango, and I am writing my PhD thesis at the Department of Environmental Planning of Brandenburg University of Technology, Cottbus, Germany. My research is supervised by Prof. M. Schmidt and is aimed at developing a quantitative methodology for verifying the SEA theory portrayed in the international professional literature. More in detail, my research aims at evaluating the extent to which SEA applied to Policies, Plans and Programme (PPPs) results in Environmental Integration (EI) in the PPPs. Attached is a questionnaire that would take you 20 minutes to complete, and it covers a relevant aspect of my research. I want to collect information on:

- The role of SEA in achieving environmental integration in PPPs;
- SEA elements (procedural, substantive, contextual) that correlate to various levels of Environmental Integration (EI);
- Potential role of quantitative methodology in evaluating SEA and Environmental Integration.

Please respond on your personal behalf, and NOT as a representative of your organisation. Your answers will be used in an aggregated manner and your identity will be treated with confidentiality. Your contribution is extremely important, and your, time, effort and collaboration is highly appreciated! Kindly email or send by post the completed questionnaire by the 25th of September, 2007 at the following addresses:
Vincent Onyango
Wilhem-kulz-str.50
03046 Cottbus
Germany.
Email: vin_onyango@yahoo.com

Thank you!

QUESTIONNAIRE SURVEY

CONTACT DETAILS

Name:

Position:

Organisation:

Address:

Email: Tel:

How would you best define your role within an SEA? (You may tick more than one option)

☐ SEA practitioner

☐ SEA administrator

☐ SEA trainer or researcher

☐ NGO (Non-governmental organization) representative or participant in SEAs

☐ Other If OTHER, please specify:

Section A: Understanding of Environmental Integration (EI)

1. In your country's legislative and administrative framework, what is understood by the term "environment"?

☐ Ecological and biophysical aspects

☐ Social aspects

☐ Cultural and historical aspects

☐ Landscape (built and natural aspects)

☐ Health aspects

☐ Other If OTHER, please specify:

2. In your country's legislative and administrative framework, is the expression "Environmental Integration" used?

☐ Yes ☐ No

If YES, please specify what it means and the context in which it is used:

If NO, please specify the expressions used that have meanings or implications similar to Environmental Integration (EI):

3. Which of the following definitions of Environmental Integration (EI) bests represents the way in which EI is intended in your country's legislative and administrative framework? EI means (You may tick more than one box):

☐ Balancing environmental aspects with socio-economic aspects

☐ Using the environmental within its carrying capacity

☐ Complying with legal environmental provisions or requirements

☐ Providing environmental baseline information

☐ Identifying potential environmental problems

☐ Addressing and provision of effective means to manage environmental concerns related to a Plan or Programme

☐ Addressing environmental opportunities and limitations related to the PP

☐ Other If OTHER, please specify:

Section B: Role of SEA in ensuring Environmental Integration in PPs

4. The international SEA literature suggests that improved environmental integration will occur as a result of SEA. Do you PERSONALLY agree with this statement?

☐ Yes ☐ No

If NO, please state why SEA does not result in improved EI:

5. Please indicate to what level SEA satisfies your expectation in integrating the environment in Plans and Programmes (PPs)

☐ Very satisfying

☐ Satisfying

☐ Neither satisfying nor dissatisfying

☐ Dissatisfying

☐ Very dissatisfying

☐ Do not know

6. Based on your PERSONAL experiences or within your organisation, have you encountered proof or evidence of improved EI as a result of an SEA application?

☐ Yes ☐ No

7. If YES, in what form was the proof and evidence?

☐ It was written in an SEA's environmental report or statement, but without any proof or empirical evidence of achieved EI as a result of SEA

☐ It was written in a SEA's environmental report or statement, and it was supported by proof or empirical evidence that EI can occur as a result of SEA

☐ It was indicated or stated by an SEA expert, without any proof or empirical evidence of achieved EI as a result of SEA

☐ It was indicated or said by an SEA expert, and it was supported by proof or empirical evidence that EI can occur as a result of SEA

☐ I assume or believe that SEA should always result in improved EI, but I have no proof or empirical evidence

☐ Other If OTHER, please specify:

<u>Section C: Contribution of SEA elements in ensuring improved EI</u>

8. The term "SEA elements" is hereby used to represent all SEA procedures, SEA contexts, and SEA methods or techniques. From your PERSONAL experience, is it always clear to identify and select the SEA elements that are effective in achieving "Environmental Integration"?

☐ Very clear

☐ Clear

☐ Somewhat clear

☐ Slightly clear

☐ Not clear

☐ Do not know

9. Please indicate which of the following procedural (Table 1) and contextual elements (Table 2) are in place in your country's legislative and administrative framework. Also indicate how effective they are in achieving EI:

Table of SEA procedural elements

SEA PROCEDURAL ELEMENTS	**PRESENCE OF ELEMENT**	LEVEL OF EFFECTIVENESS				
		Very effective	Effective	Effective/not effective	Not effective	Do not know
Screening	☐Yes ☐ No	☐	☐	☐	☐	☐
Scoping	☐ Yes ☐ No	☐	☐	☐	☐	☐
Environmental baseline	☐ Yes ☐No	☐	☐	☐	☐	☐
Public participation / Consultation	☐ Yes ☐No	☐	☐	☐	☐	☐
Impact assessment	☐ Yes ☐ No	☐	☐	☐	☐	☐
Mitigation	☐ Yes ☐ No	☐	☐	☐	☐	☐
SEA Report	☐ Yes ☐ No	☐	☐	☐	☐	☐
Monitoring & evaluation	☐ Yes ☐ No	☐	☐	☐	☐	☐

Table of SEA Context elements

SEA CONTEXT ELEMENTS	PRESENCE OF ELEMENT	LEVEL OF EFFECTIVENESS				
		Very effective	Effective	Effective/ not effective	Not effective	Do not know
Legal requirements for SEA	☐ Yes ☐ No	☐	☐	☐	☐	☐
Legal requirements for planning	☐ Yes ☐ No	☐	☐	☐	☐	☐
SEA guidance & manuals	☐ Yes ☐ No	☐	☐	☐	☐	☐
Legal environmental requirements	☐ Yes ☐ No	☐	☐	☐	☐	☐
SEA expertise	☐ Yes ☐ No	☐	☐	☐	☐	☐
SEA technical capacity	☐ Yes ☐ No	☐	☐	☐	☐	☐
(Approving) Authority	☐ Yes ☐ No	☐	☐	☐	☐	☐
Availability of data	☐ Yes ☐ No	☐	☐	☐	☐	☐

<u>Section D: Quantitative evaluation of SEA and Environmental Integration (EI)</u>

The term “quantitative evaluation” refers to use of data mainly in the form of numbers, (e.g. as opposed to checkboxes or qualitative criteria only), to quantify EI or SEA.

10. Do you think it is possible to quantify the amount of improved EI resulting from an SEA application?

☐ Yes ☐ No

If YES, please specify how

If NO, please suggest ways to prove that EI has occurred as a result of SEA:

11. Do you think SEA should be quantitatively evaluated?

☐ Yes, in all SEAs

☐ Yes, in some, but not all SEAs

☐ Yes, but in very few SEAs

☐ Possible, but lacks adequate methodology to do this

☐ No, quantitative evaluations or methods fail to acknowledge the strategic nature of SEA

12. Do you think a methodology for quantifying EI is needed?

☐ Yes, in all Plans and Programmes (PPs)

☐ Yes, in some, but not all PPs

☐ Yes, but in very few PPs

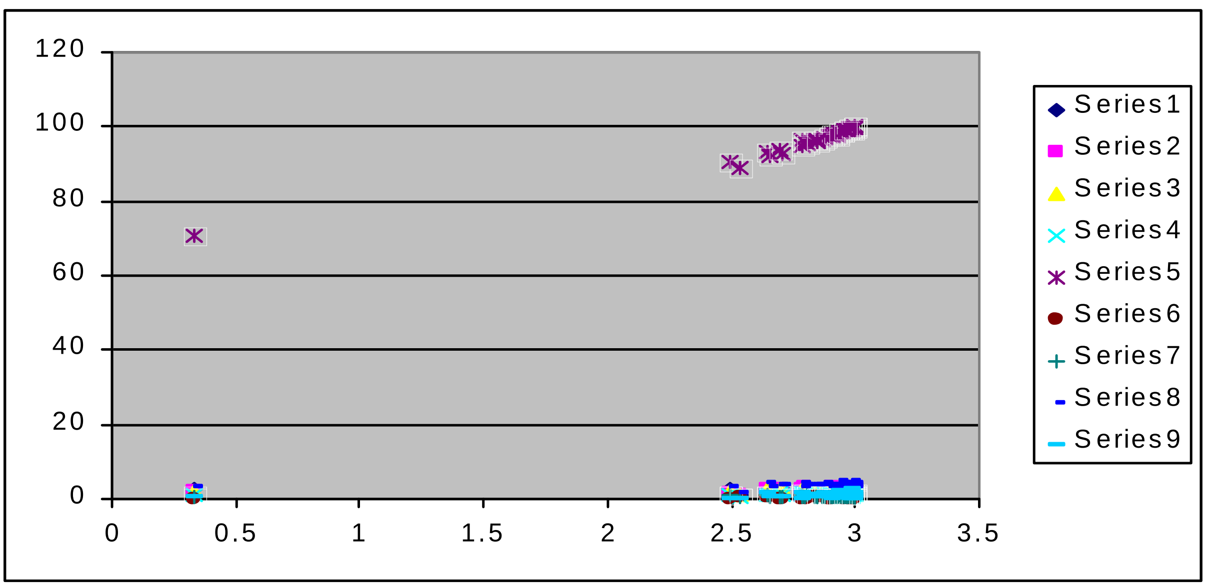
☐ Possible, but lacks adequate methodology to do this

☐ No, quantitative evaluations or methods fail to capture the nature of Environmental Integration

Please provide any comments or suggestions over the questionnaire:

Thank you!

Annex 7: Scatter diagram for the SEA and EI data sets, generally showing linear and curvilinear patterns



Annex 8: Comparisons for **Questionnaire** factor **RATING** in SEA effective procedures **using SIGMASTATS** (All Pairwise Multiple Comparison Procedures (Holm-Sidak method)). The differences in the mean values among the **SEA INDICATOR RATING** groups are greater than would be expected by chance; indicating a statistically significant difference exists among the ratings (P = <0.001) denoted by (Y). No significance was denoted by (N).

Comparison Significance (Y / N)	Diff of Means	t	Unadjusted P	Critical Level
EFFECTIVE vs. NO IDEA (Y)	7.667	16.064	0.000	0.009
EFFECTIVE vs. VERY EFFECTIVE (Y)	7.500	15.715	0.000	0.010
EFFECTIVE vs. INEFFECTIVE (Y)	4.833	10.127	0.000	0.013
INEFFECTIVE vs. NO IDEA (Y)	2.833	5.937	0.000	0.017
INEFFECTIVE vs. VERY EFFECTIVE (Y)	2.667	5.587	0.000	0.025
VERY EFFECTIVE vs. NO IDEA (N)	0.167	0.349	0.731	0.050

Annex 9: Comparisons for **Questionnaire** factor **RATING** in SEA contextual elements **using SIGMASTATS** (All Pairwise Multiple Comparison Procedures (Holm-Sidak method)). The differences in the mean values among the **SEA INDICATOR RATING** groups are greater than would be expected by chance; indicating a statistically significant difference exists among the ratings (P = <0.05) denoted by (Y). No significance was denoted by (N).

Comparison Significance (Y / N)	Diff of Means	t	Unadjusted P	Critical Level
EFFECTIVE vs. VERY EFFECTIVE (Y)	3.000	4.673	0.000	0.009
INEFFECTIVE vs. VERY EFFECTIVE (Y)	2.700	4.205	0.000	0.010
EFFECTIVE vs. NO IDEA (Y)	2.500	3.894	0.000	0.013
INEFFECTIVE vs. NO IDEA (Y)	2.200	3.427	0.002	0.017
NO IDEA vs. VERY EFFECTIVE (N)	0.500	0.779	0.441	0.025

Annex 10: Description of key steps in the Prof. Vester Sensitivity Analysis model

Steps		**Brief description**
1	System description	Key variables, giving extensive descriptions are entered and constantly updated
2	Variable set	Resultant gene pool of the system model automatically distributed to all parts of the system through a relational database
3	Criteria matrix	18 criteria for screening for a viable system (e.g. spheres of life - people, economy, ecology; ways of communication - infrastructure, laws & culture)
4	Impact matrix	Establishes levels of interactions among and between variables
5	Systemic role	Determined from calculation of index of influence, between active, reactive and critical, buffering. Variable evaluated cybernetically based on interdependencies then distributed to reveal cybernetic role, graphically i.e. as a lever (active), a risk factor (critical), a measuring sensor (reactive), an inert element (buffering). First strategic hints given here.
6	Effect system	Pattern to reveal actual interrelation among variables
7	Feedback cycles	Allows recognition of dominant cycles, relationship between self-control and mutual amplification.
8	Partial scenarios & Simulation	Cluster analysis to facilitate cybernetic examination of especially interesting areas of the system in a clearer way.

Impact Matrix

This determines the level of interactions between system components by comparing all variables in a cross-impact table. The question is: If variable ‘A’ changes, how strongly does it directly cause a change in variable ‘B’? Some variables are redefined and described anew, and from three sets of matrices from the respondents, one ‘consensus table’ is created. It forms the basis for the calculation of the index of influence of each variable. From this calculation, variables are classified into four categories, ‘active’ and ‘reactive’ on one hand and ‘critical’ and ‘buffering’, on the other. Through the influence table the cybernetic role of the system is depicted. The model calculates a quotient (Q-value) that reflects the active or reactive character of a variable. A higher quotient means the variable has significant influence within the system. However, to know how strongly a variable plays a role in the system, the product (P-value) of each Active Sum (AS) and Passive Sum (PS) is required. The bigger the product, the greater the role played by the variable, implying the variable is critical. A smaller product reflects a buffering role. The variables are then distributed on a two dimensional diagram in which the current position of a variable between the four key roles (active, reactive, critical, buffering) can be seen at a glance and properties assigned. It is here that the cybernetic analysis is done, calculated from values input originally from the table of influence. According to variable pattern distribution to the four corners, it is graphically revealed whether the variable is active, reactive, critical, or buffering. The positions from the influence table enter the Sensitivity Model's systemic role, where the interdependency of every variable is evaluated cybernetically. The goal of the systemic module is to obtain a sufficient descriptive model of the SEA system, including specifications about boundaries, indicators, and dynamics. This concept is compatible with the Structure-Function-Context model of the Bio-Ecological Potential Analysis (Scholz and Tietje 2002), linking structure (boundaries, indicators), functions (interrelations, dynamics), and context (inter-linkages) of a system in a comprehensive assessment approach. This ensures that the various key structural, functional and dynamic linkages that characterise the SEA complex are described, as in all systems being modelled (Deelstraa et al. 2003; Mulvihill 2003).

Effect Matrix

The pattern of the effect system is built up independently from the influence table, so that faults in the simulation, if any, do not perpetuate from there. The Effect System's purpose is to connect and link the variables according to either an opposing or confirming effect from one variable to another.

Partial scenarios and simulation

A "scenario" is a hypothetical sequence of events constructed for the purpose of focusing attention on causal processes and decision points. Scenarios facilitate the cybernetic examination of especially interesting areas of the system in a clearer way, by breaking the parts into more detailed sub-parts, and rendering visible the potential levers for improving the system. These partial scenarios are simulated to explain the dynamics and significance of the feedback cycles, which have been defined in the previous steps. Since partial scenarios are not linked to the main Effect System, the chance of importing wrong information from the effect system's open and complex system to the scenario system is avoided. Some constraints of Prof. Vester's Sensitivity Model are discernible, at least within the context of this dissertation. One, it is typically limited to analyzing one coefficient at a time, instead of several simultaneously. Two, the modeler must hold inherent uncertainty about the parameter values he uses as estimates, as they are obviously different in the real world. Fortunately, a great level of accuracy is not necessary to make the model sufficiently useful and valid. Simulations in Prof. Vester's Sensitivity Model are akin to a policy test. Understanding and mastering the complexity of SEA lies in recognizing the essential patterns that shape the interaction of crucial aspects or elements (critical variables) of SEA system, so that one can then focus on a reduced set of data that capture these patterns (Vester 2007). Simulation is not a prognosis, but an instrument for policy tests ('and' 'if' 'then' analyses) in order to test different strategies for a selected group of inter-related variables. To determine the stability of a system, Prof. Vester's Sensitivity Model relies on eight criteria based on nature's ways of maintaining balance and equilibrium. These are described as:

First Rule: Negative Feedback - While Positive feedback is necessary in order to get things started, a feedback control system stabilizes itself within a reach of limiting values via negative feedback. A subsystem in which positive feedback loops prevail will thereby create a vicious circle.

Second Rule: Independence of the System's Function from Growth - The settling down of a system to a stable equilibrium is not compatible with continuous growth, but is a balancing act between growth (unstable, temporary) and function (stable, permanent) that is optimal.

Third Rule: Independence of the System's Function from a Specific Product - A system's independence from its products gives great flexibility as opposed to being fixed on to specific products for development (Product fixation). Since system products come and go, while function is permanent, only function-oriented systems will survive in the long run.

Fourth Rule: The Jiu-Jitsu Principle Instead of the Boxing Method - This principle aims at utilizing already existent forces and energies by softly guiding them in the desired direction, rather than stupidly fighting and reducing them to zero with all strength, only to spend further energy

Fifth Rule: The Principle of Multiple Use - Viable systems show a preference for products and processes by which they can kill two (or even more) birds with one stone - a variation of the Jiu-Jitsu theme. That is, what we create or do should serve more than one purpose at a time, and we should solve problems with several partial solutions and not with one 100% solution (which implies that a failure also means a 100% failure).

Sixth Rule: The Principle of Recycling - This calls for a departure from the linear, uni-dimensional mode of thinking that knows only beginning and end, definite causes and effects. The shift should be towards reintegration of system elements as much as possible, in recognition of the complex dynamical interactions among the elements.

Seventh Rule: The Principle of Symbiosis - Symbiosis is the coexistence of different species to their mutual benefit, leading to considerable savings in raw material and energy; all participating elements benefiting from each other’s contributions

Eighth Rule: Basic Biological Design - Every product, every function and organization should be compatible with the biology of man and nature. Design and planning must be controlled by feedback from the environment for instance, from the social environment, by participation of citizen groups.

Annex 11: Questionnaire for Sensitivity Analysis

Dear Sir / Madam,

RE: BRIEF INTRODUCTION TO THE INTENDED EXERCISE

This exercise shall generate a relationship and interplay between the SEA elements that influence EI within an SEA process. The results shall be entered into a Sensitivity Model (Modelled by Prof. Vester). The Sensitivity Model is a trans-disciplinary modelling approach developed "to assist groups of experts from different reality domains to build a common language as opposed to the prevalent jargons of specific areas of expertise". By centering on the interrelatedness of issues in the real-world it puts strong emphasis on the analysis of its inherent causal structures. A fundamental assumption is that processes in reality can be described by applying circular causal logic, i.e. feedback thinking (see http://www.sgzz.ch).

This research aims to apply the Sensitivity Model to an SEA system and examine the extent to which SEA behaves 'systematically' in fulfilling its purpose of delivering Environmental Integration (EI). This is done by:

1) Defining the interrelatedness of the different SEA elements that define a functioning SEA system e.g. procedural, substantive and contextual elements/parameters;

2) Analysing the dynamic relationships between the SEA elements within the SEA system;

3) Simulating the extent to which the SEA elements interact in delivering EI.

In this context, it is assumed that Prof. Vester Sensitivity Analysis Model can simulate the various scenarios in which SEA can deliver a wide range of levels of EI.

INSTRUCTIONS / GUIDANCE TO FILL THE PAIR-WISE MATRIX

Please note that the SEA elements have been defined in the Table below. You **MAY ALTER** any of those definitions to suit your own interpretation / context, according to your chosen sector. **FILL ONLY IN THE CLEAR (UNSHADED) BOXES. PLEASE FILL IN ALL THE BOXES**.

Use only your estimation / opinion to enter the scores, and follow the following simple steps:

- Since SEAs are sector / context specific, pick any sector of your choice, to help you focus on scoring the matrix.
- Please state the sector you have selected:
- Start with the first item in the row (e.g. 1A), and compare with each column item (e.g. 1B, 2B, 3B…18B). Then go to second row, and compare with each column. Do this from row 1 to row 28.

Table 2: Indicative definitions for SEA elements

	SEA ELEMENT	DESCRIPTION
1	Scoping	Determining environmental issues, problems, scale & boundaries to be addressed by the SEA: Terms of Reference
2	Describing env. baseline	Current status of the environment e.g. type of environment; types of trends / changes; environmental problems; links to other PPPs etc
3	Predicting env. impacts	Forecasting the potential environmental impacts from proposed PPP
4	Evaluating env. impacts	Assessing, evaluating potential impacts for significance, intensity, duration; time of occurrence; costs; risks etc
5	Identifying PPP alternatives	PPP alternatives that can fulfil intended PPP objectives
6	Evaluating PPP alternatives	Evaluating environmental impacts of each PPP alternative
7	Mitigating impacts	Measures, actions to avoid, prevent, reduce or compensate for adverse impacts
8	Decision-making & Review	Precise & concise documentation of SEA findings & recommendations; its review for adequacy, accuracy, relevance etc

9	Public Participation	Iteratively collecting stakeholders' views; reporting decisions to stakeholders and getting their views on it.
10	Monitoring & valuation / SEA follow-up	Periodically collecting data on status of environment; comparing it with predicted / standard levels; and adjusting PPP accordingly
11	Env. & Sustainability objs	Explicit environmental & sustainability objectives & agenda stated in the Scope or Terms of Reference
12	SEA regulations, laws	Legal regulations & laws on SEA requirements, provisions; how an SEA exercise should proceed, and what it should deliver; terminologies
13	National / Sector env. objs	Environmental objectives, targets, benchmarks e.g. in national or sector Action Plans or strategies
14	Environmental laws	Existence of enforceable environmental laws, rights, responsibilities, liabilities, offences; retribution; restitution etc
15	Public and Civil Society Awareness	Public's awareness of values, rights, duties, responsibilities towards the environment
16	Quality Control	Independent & external body that reviews, approves SEA reports
17	Political Will	Existence of political & policy support for use of SEA
18	Planning Systems	Existence of formal planning system(s) that can be used for environmental integration

SCORING CRITERIA: INSTRUCTIONS / GUIDANCE TO FILL THE PAIR-WISE IMPACT MATRIX

The question is If I change A, how strongly will B be changed? or to what extent will B be affected? ONLY direct effects are considered. Attention is paid to the DIRECTION of effects only e.g. "effects from A to B" are considered and not "effects from B to A". In some places "environment" shortened to "env" and “objectives to “objs”

Score	Criteria
0	A has no influence on B
1	A has slight (little, minimum) influence on B
2	A has large (considerable, significant) influence on B
3	A has very strong influence on B

The below pair-wise matrix is a sample of the one filled in (with grid) by the three respondents. The scores were taken into the Sensitivity Matrix impact matrix, where a consensus matrix was created

A ↓ Compared with B →		Scoping 1B	Describing env. baseline 2B	Impacts evaluation 3	Identifying PPP alternatives 4	Evaluating PPP alternatives 5	Mitigating impacts 6	Decision-making and review 7	Public participation 8	M&E; SEA follow-up 9	Env. & sustainability objs 10	SEA regulations, laws 11	National / sector env. objs 12	Environmental laws 13	Public, civil society awareness 14	Quality Control 15	SEA team & expertise 16	Political will 17	Planning Systems 18
Scoping	1A																		
Describing env. baseline	2A																		
Impacts evaluation	3																		
Identifying PPP alternatives	4																		
Evaluating PPP alternatives	5																		
Mitigating impacts	6																		
Decision-making & review	7																		
Public participation	8																		
M&E; SEA follow-up	9																		
Env. & sustainability objs	10																		
SEA regulations, laws	11																		
National / sector env. objs	12																		
Environmental laws	13																		
Public, civil society awareness	14																		
Quality control	15																		
SEA team & Expertise	16																		
Political will	17																		
Planning systems	18																		

Legislations, Norms and Regulations

Legislations and Regulations

Air Quality Framework Directive - Council Directive 96/62/EC of 27 September 1996 on the ambient air quality assessment and management, OJ L 296 of 21.11.1996 p. 55.

EC Treaty –Treaty establishing European Community, OJ C 325 of 24.12.2002, p. 33

EIA Directive – Council Directive 85/337/EEC of 27 June 1985 on the assessment of the effects of certain public and private projects on the environment, OJ L 175 of 05.07.1985 p. 40, corr. OJ L 216 of 03.08.1991, p. 40, amended by Directive 97/11/EC of 03.03 1997, OJ L 73, p. 5, and Directive 2003/35/EC of 26.05.2003, OJ L 156, p. 17.

EU Treaty - Treaty on European Union, OJ C 325 of 24.12.2002, p.5.

Habitats Directive – Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora, OJ L 206 of 22.07.1992, p. 7, corr. OJ L 031 of 06.02.1998, p. 30, OJ L 059 of 08.03.1996, p. 63 and OJ L 176, 20.07.1993, p. 29, as amended by Directive 97/62/EC of 27 October 1997, OJ L 305, p. 42.

Nitrates Directive - Council Directive 91/676/EEC of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources, OJ L 375 of 31.12.1991 p. 1, corr. OJ L 092 of 16.04.1993, p. 51.

Planning and Compulsory Purchase Act – statutory instrument 2004 No.2097 (C.89, Commencement No.1), HMSO, London.

SEA Directive – Directive 2001/42/EC of the European Parliament and of the Council on the assessment of the effects of certain plans and programmes on the environment from 27.06.2001. OJ L 197 of 21/07/2001, p. 30.

The Environmental Assessment of Plans and Programmes (Scotland) Regulations 2004 (Scottish Statutory Instrument 2004 No. 258)

The Environmental Assessment of Plans and Programmes (Wales) Regulations 2004 (Welsh Statutory Instrument 2004 No. 1656 (W.170))

The Environmental Assessment of Plans and Programmes Regulations 2004 (Statutory Instrument 2004 No.1633)

The Environmental Assessment of Plans and Programmes Regulations (Northern Ireland) 2004 (Statutory Rule 2004 No. 280).

Waste Framework Directive – Council Directive 75/442/EEC of 15 July 1975 on waste, OJ L 194 of 25.07.1975 p. 39.

Water Framework Directive, Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy, OJ L 327 of 22.12.2000, p. 1, corr. OJ L 017 of 19.01.2001, p. 39.

Wild Birds Directive – Council Directive 79/409/EEC of 2 April 1979 on the conservation of wild birds, OJ L 103 of 25.04.1979, p. 1, corr. OJ L 059 of 08.03.1996, p. 61, amended by Directive 97/49/EC of 29 July 1997, OJ L 223, p. 9.

Norms

Aarhus Convention – UN ECE Aarhus Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters, prepared in Aarhus, Denmark, in 1998, the Reporting Directive – Council Directive 91/692/EEC of 23 December 1991 standardizing and rationalizing reports on the implementation of certain Directives relating to the environment, OJ 377 of 31/12/1991.

Convention on Biodiversity, concluded at Rio de Janeiro, 5 June 1992.

Espoo Convention – UN ECE Convention on Environmental Impact Assessment in a Transboundary Context prepared in Espoo, Finland, 1991. Available from http://www.unece.org/env/eia/eia.htm. Last accessed

21/09/2007.

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Ramsar Convention – Convention on wetlands of international importance especially waterfowl habitat, 1971, www.ramsar.org/index_very_key_docs.htm Last accessed 12/11/2008.

Rio Declaration – Rio declaration on environmental and development, 1992, www.un.org/documents/ga/conf151/aconf15126-1annex.htm. Last accessed 10/12/2008.

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